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AVIATION

The Oldest American Aeronautical Magazine

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Assistant Editor

AVIATION

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The Oldest American Aeronautical Magazine

EDWARD P WARNER, *Editor*
LESLIE E. NEVILLE, *Managing Editor*
LOUIS F STOLL, *Publishing Director*

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Volume 31

January to December, 1932

GENERAL INDEX

*Illustrated, (ed) Editorial, (F) Feature article, (L) Letter

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INDEX OF AUTHORS

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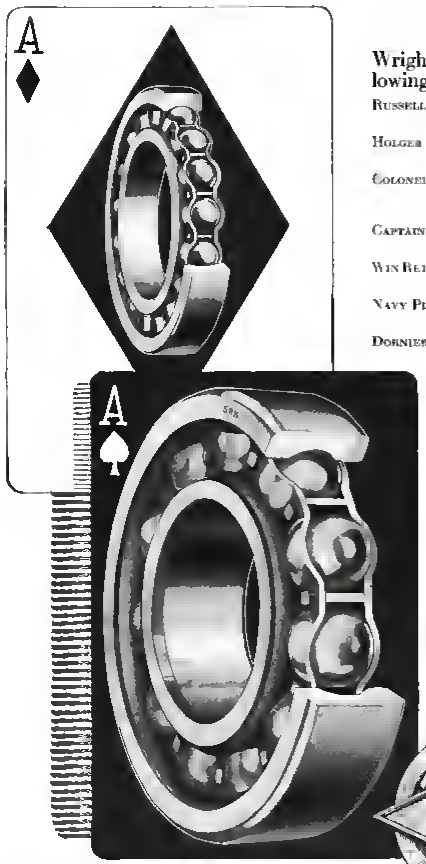
Aviation's "Ace" Accomplishments *in* 1931 *were made with* SRB Ball Bearings



Wright

Wright engines powered all planes responsible for the following achievements of 1931:

RUSSELL BOARDMAN AND JOHN POLANDO establish new long distance, non-stop record . . New York to Turkey

HOLGER HOIBRIS AND OTTO HILLIG make trans-Atlantic flight . . New York to Germany

COLONEL AND MRS. CHARLES A. LINDBERGH fly from New York City to Tokio via Canada and Alaska, covering 7,132 miles.

CAPTAIN FRANK M. HAWKS sets 6 new inter-city speed marks between European capitals

WIN RELIABILITY TOUR—the Cyclone and Whirlwind powered Ford tri-motor scores 10,000 points over nearest competitors

NAVY PLANES MAKE RECORD. A squadron of 8 Martin "PM" Patrol boats make non-stop, over water flight of 700 miles.

DORNIER DO-X—world's largest airplane powered with 12 Curtiss Geared Conquerers completes 12,000 mile journey

HAWAIIAN ISLANDS CIRCUMNAVIGATED—a squadron of patrol boats covering the 840 miles in 11 hours and 20 minutes.

$ 025 MILE BUSINESS TRIP COMPLETED IN 15 HOURS—Bernarr McFadden, New York publisher, keeps business appointments in 20 cities.

S R B Ball Bearings used in all Wright engines

Lycoming

An outstanding service record

The Century Pacific Air Lines using Stinson Tri-motor planes powered by 3 Lycoming R-680 Engines have completed over 2,430,000 engine miles without any mechanical failures. Similar service records are being established by Century Air Lines (Chicago) and Ludington Lines, Inc.

S R B Ball Bearings used in all Lycoming engines

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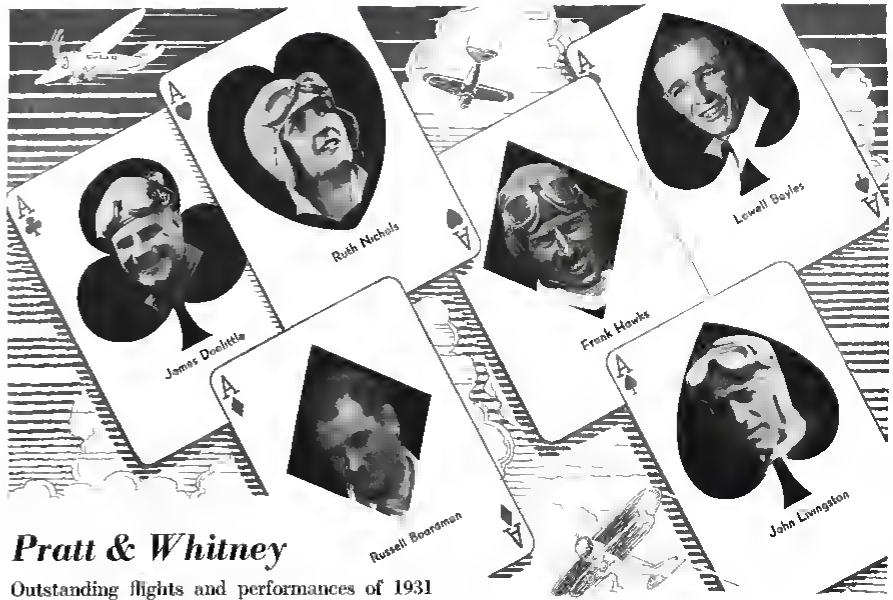
STANDARD STEEL AND BEARINGS INCORPORATED



Pratt & Whitney

Outstanding flights and performances of 1931 with planes using Pratt & Whitney engines

AROUND THE WORLD RECORD—Wiley Post and Harold Gatty circle the globe in 8 days, 15 hours and 51 minutes.

NON-STOP FLIGHT FROM JAPAN TO THE UNITED STATES—Clyde Pangborn and Hugh Herndon complete flight around the world . . making non-stop flight from Japan to the United States in 41 hours and 15 minutes

NEW TRANSCONTINENTAL RECORD—Major James H. Doolittle flies from Burbank, California, to New York City in 11 hours and 16 minutes—average speed 217 miles per hour

LOWELL BAYLES WINS THOMPSON TROPHY RACE—Covers the 10 laps of the 10 mile closed course at a record speed of 236.239 miles per hour

NATIONAL AIR RACES—Pratt & Whitney powered ships entered in 12 races. They took 11 first places, 9 second places and 5 third places in these events.

TRANS-ATLANTIC FLIGHT—Captains Georges Endres and Alexander Magyar fly from New York to Budapest, Hungary

WOMEN'S ALTITUDE RECORD—Miss Ruth Nichols climbs to 28,743 feet—a world's record

NEW SPEED RECORD FOR WOMEN—Miss Ruth Nichols establishes an official speed record of 210.636 miles per hour—a world's record

WOMEN'S COAST TO COAST RECORD—Miss Ruth Nichols makes new record in flight from Los Angeles to New York.

ENGLAND TO CAPE TOWN, SOUTH AFRICA—Commander Glen Kidston established a new speed record for this 7,800 mile journey.

S R B Ball Bearings used in all Pratt & Whitney engines.

Warner

These brilliant performance records were established by Warner powered aircraft at the 1931 National Air Races.

TRANSCONTINENTAL HANDICAP AIR DERBY. Santa Monica, Calif., to Cleveland. Women's Division, 1st and 3rd. Men's Division, 3rd.

SPEED AND EFFICIENCY CONTEST FOR SINGLE MOTOR PLANES. Warner Cessna planes won 1st and 2nd places.

MEN'S EVENTS	510 cu. in. free-for-all	1st and 3rd
	510 cu. in. A. T. C. Race	1st, 2nd and 3rd
	650 cu. in. free-for-all	1st and 3rd
	650 cu. in. A. T. C. Race	1st, 2nd and 3rd
	800 cu. in. free-for-all	2nd
	800 cu. in. A. T. C. Race	1st
	1000 cu. in. A. T. C. Race	2nd
	1200 cu. in. A. T. C. Race	1st
WOMEN'S EVENTS	510 cu. in. free-for-all	1st and 3rd
	650 cu. in. A. T. C. Race	1st and 3rd

S R B Ball Bearings used in all Warner engines

SRB BEARINGS

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AVIATION
FOR JANUARY, 1932

The story of 1931

The time has come for another year-end accounting in the aeronautic industry, and in the accompanying review we have attempted to provide an accurate reproduction of both sides of the ledger. The period of adjustment has not yet passed. A careful look at the record, as set forth in the contributions of Admiral Moffett, Major Howard, Professor Taylor, and the members of AVIATION's staff, should be helpful in planning for the year to come.

THERE is an air of resignation throughout the aeronautic industry as its members pass their time smoothing out the wrinkles of deflation, and planning for a sound future The prosperous and wasteful dream of 1929 is far behind, the desperate distribution nightmare of 1930 has passed The industry is now in approximately the same relative position that it held before the abnormal expansion of 1928-1929,—with the advantage of three more years of experience and technical development on which to build

By far the brightest spot is the transport field While the operators are not without their problems, they can face them with the satisfaction provided by constantly increasing passenger patronage and mail and express loads Air express poundage, particularly, has increased tremendously over 1930 figures All air transport lines are moving rapidly toward financial independence, and traffic increases are shown while steamship and railway patronage continue to fall off. Perhaps the greatest encouragement is derived from the knowledge that at least one independent line, operating without benefit of mail contract, has shown a profit in the first year of operation.

It is certain that, as soon as business conditions return to normal, there should be a tremendous increase in demand for air transport services Meanwhile the operators are strengthening their organizations from within by cutting costs. Of these the major factor is maintenance, representing a very large proportion of the total operating expense. One of the greatest problems now confronting operators is the reduction of this item.

There is a strong trend toward closer cooperation between designer and maintenance engineer, and it has been found more economical to develop an entirely new transport design than to attempt to adapt one from a machine intended for some other service.

Maintenance services, other than those primarily associated with transport lines, have grown during the past year While increased stress on service work, and the keeping in service of machines that might otherwise have been scrapped, is the natural result of depression in all industries, there are indications that in the aeronautic field there is a normally growing demand for reputable and efficient services of this type for operators other than those engaged in regular transport work. Airplane and engine life have been lengthened considerably by improved maintenance methods

In 1931, the bulk of production has been for the military services Approximately 70 per cent of the dollar value of the total production, or about 23 millions of dollars, constituted fulfillment of military and naval contracts necessary for the concluding stages of the Army and Navy five-year procurement programs. The remainder, the non-military production, can be divided into three groups A little more than 50 per cent of the dollar value came from transport orders, while 34 per cent represented aerial service, business, and private machines The remaining 13 per cent covered the light plane production value.

It is obvious from these simple figures that the scourge of deflation has had its

In this and subsequent issues of AVIATION, *the section devoted to editorial comment, which heretofore has begun on this page, will follow the feature section "News of the Month," and the statistical pages follow in order "Side Slips" appears at the beginning rather than at the end of the department section.*

most deadly effect on the producers for non-military markets. Many of them have closed down their plants entirely, either permanently or pending a return of normal business conditions. Undoubtedly the greatest sufferers are found in the light plane group, bearing out the predictions made early last year in our article "The Light Plane Situation"— (AVIATION, February, 1931). The light plane boom, as a boom, has gone the way of the glider debacle of 1930, although the collapse has not been so complete and there remains behind a residue of real use and real demand for the type. The market for business, private, and aerial service planes awaits a return of normal business.

Enthusiasm in the ranks of the light plane manufacturers reached its height at the time of the National Aircraft Show, and was based more largely on dealer prospects than on ultimate consumer possibilities. In some cases the policies of 1929 were repeated on a smaller scale, but manufacturers learned that an airplane delivered to a distributor is not really sold, and disillusionment set in.

While light plane manufacturers talked of production at show time, builders of medium-weight commercial machines made definite merchandising efforts. First among them was the price war waged mainly by the makers of four-place cabin machines. Intelligent market studies were made and production adjusted to meet existing demand.

Completion of the Akron and the 40 passenger Sikorsky, and the public offering of the autogiro and the Stout Sky Car are among the outstanding engineering accomplishments of the year. A number of revivals have marked the twelve-month period. The light plane movement brought a resurrection of the two-stroke-cycle type of engine, the demand for low-cost flying instruction brought to light a species of machine closely resembling the "penguin" trainers of 1916, while in this country and in Germany there appeared two so-called tailless airplanes, the American version being a direct descendent of the historic Burgess-Dunne machine.

Aeronautic industry deflation seems to be almost complete, but the critical stage has not been passed. The future, which depends so much on the far-sightedness of our legislators, is discussed in detail elsewhere in this issue.

Design

IT IS difficult to distinguish any positive trend away from established design formulas during 1931. Progress has been made in high-speed performance largely by increase in engine horsepower and by cleaning up exposed parts, but the predictions of extensive use of slots, flaps, spoilers, and the like, which followed the wind-up of the Guggenheim contest, have failed to materialize.

The low-drag cowling of air-cooled engines has become virtually a standard practice, and considerable attention has been paid during the year by several manufacturers to the problem of developing a satisfactory retractable landing gear. The single-spar idea for cantilever wings has gained some impetus, there being one experimental machine produced in this country using this system and a successful application in England.

Designers are not only re-analyzing their structures to make the most economical use of their materials, but also have been casting about for new materials with improved strength-weight properties. Stainless steel for aircraft construction is definitely over the horizon. Not only have certain parts and accessories been made up using this alloy, but an airplane incorporating a spot welded all steel wing has been flying for some time, and another, an amphibion, recently tested, has been built entirely of spot-welded steel. The key to the successful use of this material seems to be in the development of suitable welding equipment.

Increasing attention is being paid to the question of maintenance in transport types. Operators are demanding airplanes which can be kept in the air at a cost considerably below that which can be obtained today, and designers are beginning to realize that, for commercial types at least, the question of maintenance is at least as important as that of performance.

In the accessory field the controllable pitch propellers and the Sperry automatic pilot are notable achievements.

Research

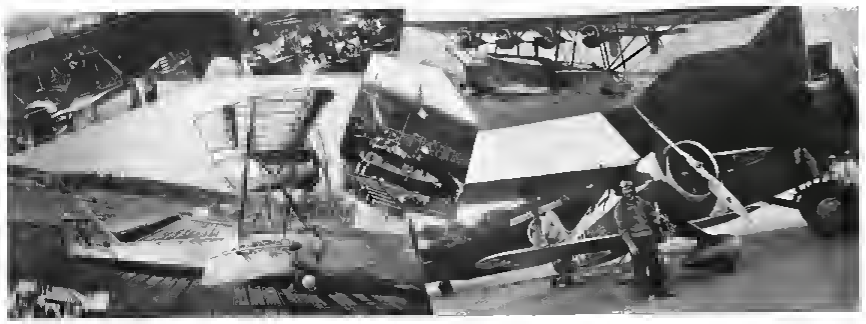
FROM the standpoint of aerodynamic research, 1931 will be remembered more as a turning point than as a period in which great advances were made. In the United States experimental work is largely in the hands of the National Advisory Committee for Aeronautics. The program for full scale investigation begun several years ago in the high pressure wind tunnel at Langley Field, gained a new impetus with the completion of a tunnel capable of handling full size airplanes up to spans of 45 ft., at air speed up to 115 m.p.h. Coincident with the completion of the full scale tunnel was the commissioning of the largest towing basin in the world.

Among other investigations which have been conducted by the committee, the more important have been those having to do with the increasing of lift on airfoils by the control of circulation, particularly in the boundary layer. Spinning research has been continued, both at full scale and on models in the new vertical wind tunnel. A new type air-cooled exhaust manifold has also been developed for the same purpose. With the acquisition of the MacDonnell Doodle Bug, the laboratory has been enabled to carry on full scale work on slot and flap combinations. Airplane control near the stalling point has also been extensively studied.

Autogiros

DURING the summer of 1931, the autogiro emerged from the purely experimental stage, and was offered to the public as a commercial vehicle. Three concerns have been licensed under the Cierva patents by the Autogiro Company of America to manufacture machines of this sort,—Pitcairn, Kellett, and Buhl. Cabin autogiros have begun to make their appearance, and Buhl is introducing a novelty by building a pusher. About 30 autogiros were delivered during the year, most of them to national advertisers.

A totally different type of rotor-wing craft has been flown by E. Burke Wilford. The Wilford machine has feathering rather than articulated vanes.



Air Corps equipment

By Maj. C. W. Howard
Chief Engineer Materiel Division Air Corps

THE Air Corps now has under construction airplanes which are outstanding and far in advance of any equipment which we know to be in use in any country. This statement is based on present actual performance with existing engines, and from apparent possibilities of these airplanes when the present engines are replaced with those that are now under development and which have lagged behind the airplane for which they were intended. This position will enable the Materiel Division to devote a great deal more attention to refinements and maintenance problems this coming year than has been possible in the past. In addition it is desired to emphasize the fact that the basic designs themselves have been laid out with the intention of using more powerful engines than are now available. In these new types full consideration has also been given to tactical functions, types of construction and fundamental premises whereby the airplanes now going to the tactical organizations can be altered with a minimum amount of expense and time in order to adapt them to requirements for new equipment which may be deemed necessary to maintain the leadership which this country now enjoys.

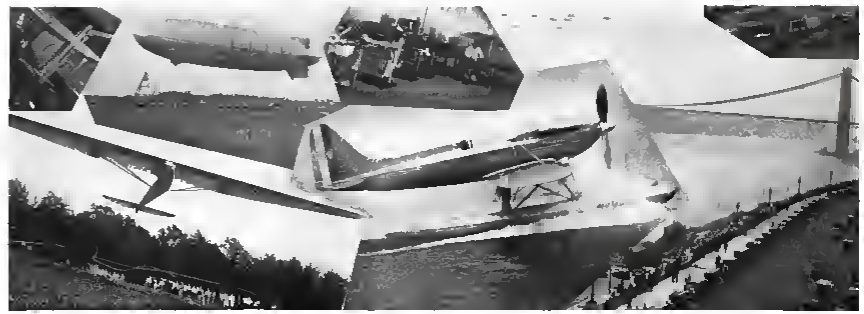
For purely tactical types the transition stage from wood to metal has been passed. The welded steel structura will continue to be used for cargo and training types. The built-up metal structures analogous to the steel strip developments in other countries have not proved of sufficient worth for adoption in this country. For fuselages, the metal monocoque employing duralumin will predominate, and it is believed that the expensive method of riveting and bolting skin and structural members together will be shortly replaced by the more satisfactory, expeditious, and cheaper method of spot welding, which is now under development for both steel and the light alloys.

As for wing structures, both the internally braced and the cantilever monoplane types metal covered and fabric covered are employed.

The goal being sought for all types of airplanes, except transport and pursuit, is 200 m.p.h. with full military load. The pursuit types will have performance in the order of 250 m.p.h. A comprehensive series of tests extending over two years has been concluded at the Materiel Division in an endeavor to obtain an improved, cheap and low-powered training airplane. After considering practically all commercial trainers and testing scores of combinations in specially constructed airplanes, the very light trainer was definitely abandoned. The desires of the Air Corps Training Center have expanded with the progress of aviation. The airplane which merely flies is no longer satisfactory as an Army trainer. The refinements so desirable in service type planes, such as improved controls, brakes, tailwheels and other equipment are beginning to be of import to instructors. Although performance has never been stressed as a primary requirement of a training airplane, it has been found that a rate of climb of over 700 ft. per min. is necessary. The new trainer, although not accomplishing a saving of power, weight, or expense over the old types that have been used for many years, contains the characteristics now desired by the training personnel of the Corps.

As has been stated many times, it is the very definite contention of the Materiel Division that the development of power plants is the most important contribution to the advancement of aircraft that can be made. With these premises in mind, studies involving the improvement of fuel, fuel injection, supercharging and work to obtain very high m.e.p.'s in engines have been energetically pursued. The results have been that throughout the Air Corps, except for training planes for which it is not required, 87 octane fuel is in use. The development is toward even higher grades. With these grades of fuel, horsepower ratings for given displacement are continuously advancing for conventional or standard engines. Methods of fuel injection which will make possible elimination of the carburetor, are still under development and apparatus is about ready for service testing. Superchargers are being installed on certain service types of airplanes and it is hoped that within the next six months the advantages of the side type supercharger will have been finally proved and this equipment will have been adopted, throughout the service, for all airplanes requiring superior performance at altitude. Mean effective pressure studies have opened up new and interesting design problems. These have resulted in the Air Corps laying down new engines involving principles not at the present time accepted as practical, with the result that if the experiments are successful, engines of displacements now commonly in use will be obtained with a great deal smaller over-all dimensions, lighter weights, and increased powers. Larger and more powerful conventional engines are also being brought out to meet the requirements of increased speed and armament necessary to fighting airplanes.

The tendency in military airplane design is still toward the highest possible speed. Inconsistent with this demand is the ever increasing requirement of improved protection, heavier armament and increased gasoline capacity.



The single seater vs the two-seater pursuit is still a moot question, which through actual experience with the airplanes under construction, it is hoped, may be answered during the next year. In addition, relative merits of thin wing wire braced monoplane versus thick wing retractable landing gear combinations still have to be conclusively settled. These features are contained in the service test equipment as well as the experimental or prototypes.

Automatic and controllable propellers are being sent out in service test quantities. Fog flying with its concurrent instrument development such as the automatic steering device, automatic pilot, sonic altimeters, sensitive altimeters, radio beacons, and radio depth finding upon approaching a field has progressed to such a state that the practical solution of the problem is very close at hand.

The immediate problem which will be undertaken by the Air Corps this coming year is, as before stated, the refining and supplementing additional power plant improvements to existing equipment. It is believed that such alteration of the equipment being purchased for the service will be sufficient to maintain the lead which now exists over other countries and that as soon as the new types of engines with radical improvements are available, another advance in performance and effectiveness may be expected of the airplanes laid down around such power plants.

Naval aeronautics

By Rear Admiral W. A. Moffett, U.S.N.
Chief of the Bureau of Aeronautics.

THE aeronautical year 1931, from the standpoint of the U. S. Navy, was outstanding for its experimentation, and for the fulfillment of its development plans.

The completion of the five-year building program of 1,000 planes, authorized by act of Congress in 1926, was of vital importance to naval aviation. This building program was completed a full year ahead of schedule and with a saving of $23,307,150 over the estimate.

The past year has seen the fruition of the broad policy instituted some years back of building a large number of experimental aircraft to determine the types best suited for naval use. Under this policy approximately 40 new types of planes have been delivered to and tested by the Navy during the past year. With such a varied experimental policy it has been possible to take full advantage of the ability of practically all the important aeronautical design and engineering talent found in this country. At the same time, through lower prices, careful economy, and reduction in attrition through improvement in material and operating methods, the Board of Aeronautics has been able to make a showing of actual machines in the air of which it may justly be proud.

Experimental power plant development for the year may be summarized as follows: improvement of existing service types; research having to do with new and untried types which show promise; and improvement of engine-test facilities.

It will be recalled that the Navy gave initial and continuous support to air-cooled engine development in this country. During the past year many important improvements have been made. The power and reliability of American air-cooled engines has been shown to be superior to that of any other country in the world.

There has been an increase of approximately 50 per cent in the number of flying hours per forced landing due to engine failure. Power output per unit of displacement has been augmented markedly in current service types of engines.

A new method of rational determination of load factors for airplanes, rather than that of accepting arbitrary values, has resulted in more exact knowledge of the strength requirements of individual airplanes in the various accepted maneuvers.

Marked progress has been made in the development and utilization of high strength ferrous and non-ferrous alloys in the construction of naval aircraft, and also in the study of the use of corrosion-resisting steel for various aircraft parts. Spot welded stainless steel floats and wing ribs are undergoing service tests, while tie-rods and cables for control and mooring use, made up of stainless steel, have been installed on a number of planes.

The development and improvement of new carrier equipment has been along the lines of simplicity, durability, and safety. The same features have been stressed in catapult development, and this phase of activity has been so successful that in the past year, despite continuous operation from many vessels, there have been no major accidents due to malfunctioning of catapults.

The completion and successful trials of the U.S.S. Akron (ZRS-4) have been the high points of airship progress during 1931. This airship was designed and built as a sea-going vessel, capable of operating with the fleet on scouting missions in all weathers. The primary aim in her construction was necessarily unusual strength and habitability in order to accomplish so arduous a task. Construction of the ZRS-5, sister ship to the Akron, has already been started.

The U.S.S. Los Angeles has continued her work in connection with the training of lighter-than-air personnel and in experimentation. In addition, this airship took part in the Fleet Maneuvers in Central American waters during February, 1931. There she was in continuous operation for three weeks, at a distance of more than 2,000 miles from her hangar, using the mooring mast of the U.S.S. Patoka as a base for refueling and servicing.

Experiments with and development of the "hook-on" device for airplanes have been conducted on the Los Angeles and the results of these experiments have been applied to the U.S.S. Akron, which will carry a squadron of fighting planes which can be launched and picked up while in flight.

The U. S. Naval Air Station, Lakehurst, N. J., has been equipped with mechanical ground handling gear, on a scale never before attempted.

Two additional events of importance in the aeronautical year were the acquisition of a lighter-than-air base at Sunnyvale, Cal., to accommodate the U.S.S. Akron and the ZRS-5, and the commencement of construction of the U.S.S. Ranger, the first vessel to be built by the United States which was designed from the keel up as an aircraft carrier.

Power plants

By Prof. C. Fayette Taylor

ALTHOUGH the development of aircraft power plants in 1931 undoubtedly suffered severely from the general business depression, the year has been marked by a number of tendencies worthy of especial mention.

In the commercial field, in this country, the increase in popularity of engines of small power ratings was quite remarkable. The Department of Commerce list of 1931 engine A.T.C.'s, to date, shows six engines of less than 60 hp. out of a total of eleven. The much heralded popularity of diesel engines has not yet materialized.

Another significant tendency has been an increase in the power ratings of the larger air-cooled radial engines, usually obtained by raising the supercharger speed and compression ratio. Thus both the J-6-9 and the Wasp Junior are available with 400-hp. ratings and the larger Wright and Pratt and Whitney engines may be obtained with correspondingly increased outputs. Persistent rumors of the development of large two-row radials by both the major aircraft engine companies should bear fruit in the near future. The Curtiss-Wright Conqueror, the only liquid-cooled engine now on the American market, is being built primarily for military work and is now specifically designed for Prestone cooling.

The most remarkable European development in 1931 was the Rolls-Royce engine which won the Schneider cup race, rated at 2,300 hp., and 3,200 r.p.m. with a brake mean effective pressure of 250 lb. per sq.in. and a weight of .71 lb. per b.hp. Almost equally remarkable was the Hispano Suiza 18R, built for the 1929 Schneider cup race. This engine gave 1,680 hp. 2,300 r.p.m. with a brake mean effective pressure of 168 lb. per sq.in., and specific weight of .681 lb. *unsupercharged*.

In the field of research there has been considerable interest in the development of fuel injection systems for the spark ignition engine, both in government and in private laboratories. The N.A.C.A. has continued its work on the fundamentals of fuel injection engines, and is now able to photograph the actual combustion process. As a result of the extensive research work on fuels conducted under the auspices of the S.A.E. for the past several years, "octane number" has come to be a well-recognized quality of fuels, and most airline operators are specifying a definite anti-knock value for all fuel purchased. One large oil company has published interesting information on so-called "hydrogenated" fuels under development in their research laboratories. It appears that such fuels may have a high anti-knock value without the low flash point and fire risk of present gasolines.

Record flights

RECORD and outstanding long distance flights featured the daily grist of aeronautical news in 1931. The Post and Gatty flight around the world, 15,474 miles in 8 days, 15 hours, 51 min. was the leading distance flight of the year. Herndon and Pangborn, abandoning their round-the-world plans, flew to Japan and, after a series of legal entanglements with the Japanese government, completed the first non-stop flight in an airplane between Japan and continental United States; they covered a course of about 4,588 miles in 41 hours, 13 min. with a Wasp Bellanca.

In the meantime Boardman and Polando flew non-stop from New York City to Istanbul, Turkey, and a new straight line distance record of 5,011.8 miles. Three new records for the Australia-England course were set during the year; the present title-holder is C. A. Butler, who in November, flew a Comper Swift over the route in nine days, 2 hours, 29 min.

The England-Cape Town record was lowered twice during the year. Glen H. Kidston in a Wasp-powered Lockheed broke the 1930 record by flying the 7,800-mile route in 6 days, 18 hours. His record was bettered in the autumn, when Miss Peggy Salamau and Mr. Gordon Store covered the distance in 5 days, 6 hours, 40 min. in a Puss Moth with a Gipsy engine. Late in November Bert Hinkler, the initiator of the England-Australia contest and holder of the record at 15½ days for about two years completed a series of sensational flights quite unattended with previous publicity, with the first successful east-bound crossing of the South Atlantic. He also used a Puss Moth-Gipsy.

Among other important distance flights were the crossing of the South Atlantic by an Italian flying boat squadron in January; the Washington-Tokio journey in the summer by the Lindberghs in their Cyclone powered Lockheed Sirius by way of Hudson Bay and Alaska, and the completion on Aug. 27 of the long journey of the Do-X from Europe by way of South America. No oceanic flight in 1931 proved fatal.

The year did not lack for short speed dashes. Capt. Frank M. Hawks took his Texaco 13 abroad in the late spring for a series of fast inter-city flights which aroused considerable interest in Europe. Hawks' transcontinental record of 13 hours was lowered in August to 11 hours, 16 min. by James Doolittle, flying the Laird Solution II. Doolittle later made an Ottawa-Washington-Mexico City flight in 12 hours, 36 min.

New F.A.I. world marks for high speed were established with the new Supermarine S.6B seaplanes developed for the Schneider Trophy Contest. Flight Lieutenant Boothman won the contest, setting a new Schneider mark of 340.08 m.p.h. Later Flight Lieutenant Stainforth achieved the record of 408.8 m.p.h. over the 3 km. course. Walter Lees and Frederic Brossy brought back to this country the non-refueling endurance record with a flight of 84 hours, 33 min. Joseph Lebrix and Marcel Doret raised the closed circuit non-refueling distance record to 6,560 miles.

The American speed sensation of the

year was the Gee Bee Super Sportster, which set a new record of 236 2 m p h. for the Thompson Trophy event at the National Air Races Several unsuccessful attempts were made to set a new world landplane speed record, the last ending in a crash, and the death of the pilot Lowell Bayles

Transport activities

AMERICAN airlines in 1931 completed their first year under the Watres Bill terms, which were twice revised slightly downward during the year to meet economy requirements of the Post Office Department Most lines finished the year in a fairly strong overall condition, and with routes and schedules expanded since the close of 1930. During the first nine months of the year, passenger traffic increased about 6 per cent over the volume for the same period in 1930

Slightly more than 2,000 miles of new U S mail routes were inaugurated, chiefly as extensions to existing contracts This drew severe criticism from lines which held no contracts, but which had been operating over the new mail routes in anticipation of Post Office aid. Passenger accommodations go with the mail service, thus placing passenger service on each route on a permanent basis

One of these extensions included the Boston-Bangor route, the contract for which was given to American Airways and sublet to Boston-Maine Airways, a line sponsored by the Boston & Maine and Maine Central railroads and actually operated by Pan American Airways The experiment was important as the first airline operation sponsored directly by railroad interests

An important aspect was the further application of the frequent schedule and low fare idea of air transport, introduced by Ludington in 1930 Century Airlines became the apostle of this policy through operations in the Middle West and on the Pacific Coast. The traffic volume attracted by these frequent services served to stimulate the older lines, most of which enjoyed the benefit of mail contracts

Imperial Airways opened the Cairo-Mwanza section of the proposed route to Cape Town, and K L M and the French Air-Orient perfected their lines from Europe to the Far East, K L M stepping its fortnightly service up to a weekly one in the early autumn

Rates were lowered by a number of lines to the level of about 6 cents per mile, which had become the average on most lines in 1930, and this promises to be the standard level at least until spring or until the volume of traffic increases still more There was a slight general decrease in passenger traffic during the early summer months compared with the same months of 1930 but August and September showed good increases over the year before. The traffic volume caused increasing apprehension among railroads as to just what course they should take in meeting the growing competition

A number of new models of transport equipment appeared on the airways. Eastern Air Transport brought out its further refined Condor, and late in the year began installation of the Sperry automatic pilot on its planes The Lockheed Orion was adopted by a number of lines for high speed service, and the Northrop was used by Transcontinental & Western Air for carrying night mail over sections of its route American Airways, seeking a single-engined transport of moderate speed and generous passenger and mail accommodations, turned out its Pilgrim at its American Airplane & Engine plant. Pan American put the new S-40 in commission in the late autumn.

Both Transamerican Airlines and Pan American gave much thought to the development of trans-Atlantic air mail over the southern and northern routes. The former went so far as to sponsor two survey flights to Denmark over the sub-Arctic Norwegian interests announced the organization of a company to operate over this route, and the well-known German pilot, Captain von Gronau, completed a westward flight over the route in the same Dornier he used the year before over much the same course Pan American operated under a new mail contract between Bangor and Halifax, considered the first section of a possible northern route to Europe, during the late summer, but the recalled bid for a contract on the proposed Bermuda route was not re-issued by the Post Office Department

There was distinct improvement in the facilities for passengers at terminals Waiting rooms equalled or approached in convenience and general appointments the standards to which the American traveling public has become accustomed

Airports

PROBLEMS of operation rather than of construction, held the attention of the airport people during 1931 They were concerned with making the contemporary equipment earn as great an income as possible, and there was a distinct falling off in the volume of new projects undertaken

Outstanding projects include the $25,000,000 Air Corps training center at Randolph Field, San Antonio, the Birmingham (Ala.), Shreveport (La.), and Floyd Bennett (New York City) municipal airports, and the company port built by United at East Hartford, Conn. —Rentschler Field. Despite the depression and the slowing up of the building wave, a total of 171 commercial and 107 municipal airports were recorded by the Department of Commerce as having been added to the airport map in 1931 At the close of the year there are 645 municipal and 663 commercial airports in this country

More airports were rated by the Department of Commerce in 1931, than in any previous year, but there are still only ten rated fields, two of which have the new A-T-A designation

Airship development

INTEREST in airships in 1931 naturally was focussed on the U.S.S. Akron, especially on her trial and first service flights Though heavier by 1,000 lb than the original estimate, and some two knots slower, the airship was easily acceptable to the Navy. Tests of the strictly military features—such as the four-plane hangar within the hull, and the machine gun and bombing equipment—were scheduled later.

While the Akron was being completed, the venerable Graf Zeppelin was making important flights—one well within the Arctic Circle and three trips to Brazil with mail and passengers as part of the Zeppelin company's program for developing trans-ocean services Meanwhile construction was advanced on the new German Zeppelin (revamped to accommodate helium in the light of the R.101 disaster), designed to be the first commercial airship built specifically for trans-Atlantic operation under joint auspices of the Zeppelin and Goodyear-Zeppelin interests November saw the sale of the British R 100, sister ship of the R 101 for scrap

Gliding and soaring

GLIDING and soaring remained in 1931 on the conservative basis set in 1930 following the fiasco of the gliding movement early in the latter year. The national soaring meet was held at Elmira in August Accidents at the meet emphasized, however, that sound development of the activity must be preceded by a broader background of experience on the part of its devotees, and that the very utmost care must be taken

There was further decentralization of gliding during 1931, with a gradual slowing up of the activities of the National Glider Association because of financial difficulties The secondary or utility glider continued to be the most popular gliding and soaring vehicle, with little or no refinement in design or operating characteristics Manufacturing narrowed to two or three companies There is but one sailplane producer in this country now, and that company has strong German background Following the virtual disappearance of the N G A, there appeared two associations for the advancement of the sport, one in southern California and the other in New England

Next year's financial outlook

The Federal Budget and aviation

THE Federal Budget, that formidable document which contains the record of the estimates of every penny of expenditure and income in prospect for the government in Washington, has taken on a lean and hungry look in the last two years It used to run almost 2,000 pages, but now it musters barely half that number. But shrunken as the volume is, some of the figures that it contains are more shrunken still And particularly severe punishment has fallen upon aeronautical items

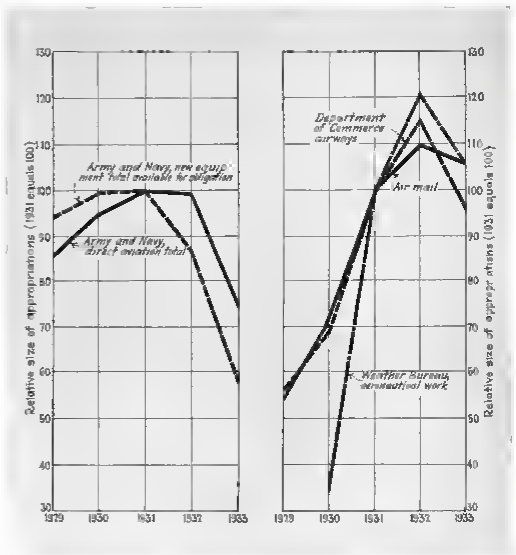
Aviation, in fact, seems to have sunk into the stepchild rôle For the first time in six years, there was no direct mention of the subject either in the President's general message to Congress or in the message accompanying the budget. Last year, a review of the federal government's aeronautical activities occupied almost a page of the budget message Only three other subjects received as much space This year, not a line. The President, in fact, accomplished what is probably an absolutely unique feat when he wrote the section of his message on national defense without letting aviation creep into it anywhere On no other occasion in the last five years, we imagine has anyone undertaken to summarize the whole field of military and naval affairs in 600 words without the slightest mention of aircraft or air power

In the fiscal year 1929 [Ending June 30, 1929. The fiscal year, always ending on June 30, is the calendar unit of all governmental finance. The present budget relates to the fiscal year 1933, which will begin on July 1 1932], the last of the Coolidge administration and the last to be completed before the depression struck, the government spent $3,300,000,000, not counting retirements of the public debt, yet receipts overbalanced that figure by almost $700,000,000. The estimates submitted for 1933 are $150,000,000 higher, largely because of a $600,000,000 increase in the cost of the Veterans' Administration, but the prospective receipts have fallen off by more than a third from the figure of four years ago, exposing the cheerless spectacle of a billion-dollar deficit.

Leaving out of account such items as the Veterans' Bureau, the payment of pensions, and the public debt, the amount proposed by the budget for the current running of the government in the coming fiscal year is $1,734,000,000, —almost the same as the expenditures of 1929, and approximately $300,000,000 less than the appropriations for the present year About one-half the total saving over 1932, however, is to be made on the Farm Board and the Shipping Board With those exceptional items left out of account, next year's budget stands about 8 per cent below that of the present year. The aeronautical items, and especially the proposed allotments for aviation in the Army and Navy, take much more than their share of the cut. The only ray of sunshine, from the aeronautical point of view, is in the fact that Congress has power to work its will on the budget recommendations. Congress has made large increases in the budget allotments for aviation before now, and Congress can do it again

Army and Navy aviation

The total appropriations for the national defense have been reduced from approximately $700,000,000 to approximately $650,000,000, a cut of 7



The ebb and flow of aeronautical appropriations. The 1931 figure is taken as 100 in every case

per cent. The budget estimates for the direct purposes of military and naval aviation, the allotments to the Army Air Corps and the Bureau of Aeronautics, are decreased from $62,625,000 to $52,133,000 a cut of 16 per cent To put it in other terms, during the present year the direct appropriations for Army and Navy aviation are just 9 per cent of the total outlay for the national defense The budget estimates for next year provide for aviation only 8 1 per cent of the total national-defense allotment. Comment is superfluous

Furthermore, from the point of view of the aircraft industry this reduction, severe enough in any case, is even worse than it appears at first sight. Congress adopted some five years ago, at the time when the five-year procurement programs were just getting under way, the device of permitting the Army and Navy to obligate the funds of future years for the purchase of aircraft. It was an expedient designed by circuitous means, to disguise the sudden increase of appropriation that accompanied the introduction of the five-year programs and to ease the shock to the sensibilities of the economically-minded The Army disentangled itself from that method of beating the financial devil around the bush a couple of years ago, but the Navy is still involved in it, and a very substantial proportion of the appropriation for naval aviation for the coming year has to be earmarked to meet the obligations of contracts already signed and to pay for aircraft already ordered and partially built The nominal estimate for naval aviation for 1933 is set at $26,660,000, as against $31,145,000 for 1932 Analysis of the proposed wording of the appropriation bill, however, shows the amounts actually available for obligations in the two years to be $24,460,000 and $30,845,000, respectively To be sure, Presidential demands for economy during the past summer are expected to result in the saving of $3,300,000 of this year's naval aviation appropriation, but even so, the amount proposed for the next year will be 11 per cent less than is being spent in the present year. The position and responsibilities of the Bureau of Aeronautics most nearly parallel, in the Navy Department, those of the Bureaus of Engineering and Ordnance Engineering and Ordnance are taking cuts of only 5 per cent and 9 per cent, respectively, as against Aeronautics' 11 per cent Furthermore, the Bureau of Aeronautics has been supporting the Administration's economy program with such whole-hearted fervor that more than 10 per cent of the present year's naval aviation appropriation is scheduled to be turned back to the Treasury unused None of the other technical bureaus, on the other hand, are expected to save as much as 1 per cent.

The Air Corps appropriations for 1932 were $31,480 000 The estimate for 1933 is down to $25,483,000, a reduction of 19 per cent, and the Air Corps is spending virtually up to the full amount of its appropriation this year, so that the 19 per cent will be a real cut of that amount in the sum available for use For comparison with that drastic revision it is noteworthy that most of the other branches of the Army undergo cuts of 5 per cent or less, and that the provision for permanent seacoast defenses (coast artillery) is cut but 15 per cent and that for transportation by horses and mules only 4 per cent Broadly speaking, more than one-sixth of the whole cut in the Army's budget is taken out of the Air Corps, which receives only one eleventh of the total Army appropriation.

Of course a very large part of these funds goes to maintenanec work, which is of only indirect consequence to the aircraft industry. What most interests the manufacturer of aircraft engines, or accessories is the amount to be expended for new equipment. And it is there that the budget cuts begin to look most painfully impressive.

Funds for buying new planes

The amount available for the maintenance and repair of naval aircraft is to be increased by $700,000 The amount for the payment of the civilian employees of the Army Air Corps is to be cut by only 1 per cent And the purchase of aircraft and engines will get slim pickings from what is left.

The budget allowance for new planes and engines, equipment, spare parts and accessories, for the Army, including the organized reserve and the National Guard, is $12 576,000 It is the lowest figure since 1928 It is 24 per cent, or almost $4,000 000, below that for the present year But the Navy fares still worse

The Navy has substantially completed its five-year program, and the budget has treated naval aviation without mercy. The total amount available for new aircraft for the next fiscal year, unless Congress shows itself more liberal than the President and the Director of the Budget have been, will be $5,800,000 Not since 1925 has there been an appropriation for naval aircraft below $11,000 000, and only once in ten years has it gone below $6,000,000 If Congress accepts the budget figures, the industry that has been built up to supply flying equipment for the military and naval services will find itself transported back into the conditions of the days before the Morrow Board.

The treatment of aviation is in sharp contrast with that meted out to the surface and sub-surface sections of the Navy While the allotment for new naval aircraft undergoes a 49 per cent reduction, expenditures for new naval vessels are actually estimated to increase by 7 per cent. The change in the number of new planes to be bought is as striking as the change in the amount of money provided for buying them The official explanatory statement reveals that the budget is based on a plan to buy 238 new planes for the Army and only 150 for the Navy during the year, as against approximately 480 and 325, respectively, this year. Not since 1925 have the total purchases in a year by the two services been below 500

There ought to be some explanation of the apparent discrepancy between these figures and the much more optimistic ones contained in various officially released tables The differences are accounted for, in the first place, by the frequent ignoring of the effect of the contract authorizations on money available for obligations and, in the second place, by the presentation of the figures representing actual payments from the Treasury instead of obligations The bookkeeping in this article, in other words, relates to the number of things that can be bought during next year, while the budget tables commonly represent the amount that is to be spent in paying the bills as they are presented They relata largely to work done a year ago

The Navy's specific allocation for instruments radio and other like accessories of aviation suffered almost as severely, with a cut from $1 800 000 to $950,000. Experimental work, on the other hand, was treated with surprising generosity, the total for the Navy remaining fixed at $2 220 000 (excluding only the $75 000 allotment made this year for the specific purpose of carrying on design work on a metal-clad airship), and the Army receiving an increase from $2,310,000 to $2 824 000

Reserves and the National Guard

The aviation reserves, by comparison, fare passably well The specific appropriation for aviation material and fuel and other supplies for the aerial section of the naval reserve has been dropped from $960 000 to $575,000, and in the explanatory statement on the budget it is said that the greatest effect of a $780,000 reduction in the total of the Naval Reserve allocation will be to "curtail the number of reserves to be given basic and advaneed aviation training." The allowance for aviation equipment for the organized reserves of the Army has been cut from $441 000 to $348,000

In both the Army and Navy the specifically aeronautical items suffer a much larger relative cut than the total of the reserve appropriations. The National Guard, on the other hand, must have made a very favorable impression by its participation in the Air Corps maneuvers last May, for $909 000 is estimated for new airplanes for the Guard, an increase of $24,000 over the 1932 figure.

The plan is to provide for 272 Air Corps reserve officers, the same number as in the present year, to go on a year

of active duty with troops The regular flying operations of the Air Corps are to be scaled down, and a saving of $2,000,000 made in operating expenses, by imposing an unprecedented limitation on flying time An average of only 165 hours per officer is to be permitted

Lighter than air craft are the beneficiary of a grant for carrying on work on the Akron's successor at a normal rate $1,450,000 will be provided. The Army's allowance for lighter-than air equipment, on the other hand, is reduced from $300 000 to the preposterous sum of $100

Air mail

To the manufacturing industry the Army and Navy sections are the most important part of the budget For the transport operator their significance is negligible, compared with that of the Post Office Department

The Post Office figures are much more encouraging In spite of the pressure for economy, which leads to an estimated reduction of the postal deficit from $195 000,000 this year to $155 000,000, and in spite of cuts of $10,000,000 in the total Post Office payroll and $9,000,000 in the allotment for rail transportation of mail, the total allowed for air mail is cut by only 4 per cent The $7,000,000 allotment for the foreign air mail is to be untouched. The reduction is all in the allowance for the domestic contract service, for which $20,000,000 is appropriated this year and for which the estimates allow only $19,000,000 in 1933 It is apparently intended that that shall involve no cancellation of routes, but that the reduction, and also any increases of compensation due to passage of a contracting line from a lower to a higher bracket under the Watres Act regulation, shall be taken eare of by reductions in unit compensation, such as have already been made twice during the last year. Presumably, however, no new routes and few, if any, increases of frequency of service on existing routes will be possible The air mail appropriation, of course, includes practically no overhead, and of the $19,000,000 estimate all but $51,000 will be directly available for payments to contractors The average amount available will be $1 579,000 as against $1,562,000 monthly for the last eight months of the present fiscal year if a deficiency is to be avoided

The air mail contractors now receive 14 per ecnt of the total amount expended for domestic transportation of all United States mails, while 18 per cent of the total sum allotted for foreign mail transportation goes to carriers by air Payments for the handling of mail by the merchant marine have been increasing more rapidly than those for foreign air mail, however, for in the fiscal year which ended last June more than 21 per cent of the foreign mail expenditure was for the aerial service, as against 18 per cent in the new budget

Airway development

As the manufacturers are most concerned with the military services and most of the transport operators with the Post Office Department, so the "independent" transport line or the small fixed base-operator or itinerant flyer have their closest governmental relations with the Department of Commerce

For Secretary Young's office the present budget, if accepted by Congress, will mark the first check in the steady increase of the appropriation for air navigation facilities that has gone on ever since the Aeronautics Branch was founded. For the present fiscal year the appropriation attained a maximum of almost exactly $9,000,000, of which $8 800 000 will actually be spent The estimate for 1933 cuts the total to $7,628,000, a reduction of 15 per cent and a figure just below the 1931 level.

There will, of course, be no shutting down of existing airways and no abandonment of maintenance work, but the estimate has been based on a total cessation of new airway construction The lighted airway system that has been growing steadily at the rate of 4,000 miles a year will be virtually static until the middle of 1933, at 19,500 miles total, unless Congress increases the budget figores

Most of the employees of the airways division are on maintenance work, and the estimated number for next year actually shows an increase of 17 per cent above the present level, to a total of 3,217 men The growing significance of the radio on the airways is plain from the air navigation facilities payroll. A year ago only 354 radio operators were employed by the Department of Commerce A year from now, according to present signs, there will be 519

The appropriation for regulations has also been cut down, again in part at the expense of the aircraft industry The estimate of actual expenditures for the current fiscal year is $1,350,000 and for next year only $1,301 000 The payroll accounting for two thirds of the total, will be practically unaffected, but the amount for the purchase of airplanes and accessories for the use of the Department is to drop from $90,500 to $75 000.

The Weather Bureau

An indispensable adjunct of the organized airways is the weather reporting service furnished by the Department of Agriculture It has expanded with great rapidity in the last three years, with the appropriation for meteorological work for the benefit of aviation increasing from $500 000 in the fiscal year 1930 to $1 779,000 in the present year In the 1933 estimates $225 000 have been cut off this year's figure, more than three quarters of the total amount of savings in Weather Bureau expenditure being taken out of the aeronautical work That is bad enough by any standard, but not quite so serious as it appears at first sight, for substantial savings are being made now, and about $160 000 of the 1932 appropriation will be unexpended The actual cut in expenditures for next year as compared with this will be only about 3 per cent, and most of that will be for equipment, which has been purchased during the fiscal year 1932 and does not need to be duplicated The Weather Bureau work, like that on airway development, will be continued substantially at its present level, but it is hardly to be expected that any expansion or improvement of the service can be undertaken.

Coast Guard and N.A.C.A.

Although the Coast Guard has never been a very large purchaser of aircraft, its expenditures for seaplanes have played an important part in the calculations of some of the manufacturing companies In the fiscal year 1931 the appropriation for new flying equipment for the coast guard was $320,000 For 1932 it was $160,000 for 1933 the item has been omitted from the budget. Taking Army, Navy, Coast Guard and Department of Commerce all together, the total available to be obligated for new planes and engines has dropped from $32,401,000 last year to $28,312,000 this, and for next year the estimate is only $18,451,000, a decline of 43 per cent in two years.

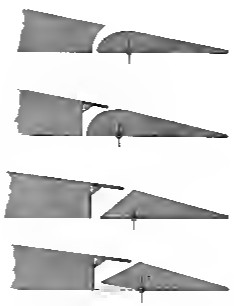
In spite of the great amount of experimental work done by the Army, Navy and Department of Commerce, all departments of the government and all units in the industry have learned to look to the National Advisory Committee for Aeronautics for most of their basic research, especially on aerodynamic questions The friendliness toward research that appears in the undiminished experimental allotment for the Navy and the increased figure for the Army is shown again in liberal treatment of the National Advisory Committee. Provision is made for a slight increase in the payroll and number of employees, the latter to a total of 330, and also in expenditures for supplies and equipment The total estimate for 1933 comes to $988,000, as against $1 026 000 appropriated, or $955 000 expected to be actually expended, in the current year If the appropriations that have been made for special building construction, such as the full-scale wind tunnel or the seaplane towing channel at Langley Field, be deducted the National Advisory Committee had, up to 1932, an unbroken record of annual increase in the sums provided for payroll and general operating expenses It is an exceptional testimony of the confidence that Congress and the administration have felt in the organization

Flying qualities are important not only to passenger and pilot comfort hut in some eases to safety. Frequently, however, they are overlooked in the early design stages and ohtained only hy modification after the machine has been constructed A test pilot should have not only wide experience in flying hut technical knowledge and executive control to enahle him to direct the necessary design modifications

Consider the passenger

By

Capt. Frank Courtney



Aileron outlines: variations on Frise theme

FEW airplanes exhibit thoroughly satisfactory flying characteristics. Performance and stability are matters for definite figures, but flying and handling characteristics are entirely a relative matter and there is no definite line dividing the good and the bad The vast majority of airplanes are mediocre in this respect They are not definitely bad but they are certainly not as good as they might be, and an experienced observer can usually pick out points where the flying qualities could definitely be improved.

This commonly is the fault of employing "test pilots" who are not test pilots Because a man is a skillful pilot it does not follow that he has the technical knowledge and analytical experience necessary for testing new airplanes, for unless there is something definitely wrong, the average pilot will leave unchallenged any qualities with which his skill is able to cope Similar troubles sometimes arise when a real test pilot is employed For example, he tests a plane and finds that, although there is nothing actually wrong, many improvements could be made To make them means time and money which engineers, executives and salesmen are unwilling to spend, and the pilot lacks the authority to force them through.

The problem of flying qualities goes deeper than merely making the plane agreeable for a pilot to fly Good flying qualities may relieve mental and physical strain automatically making a better pilot. In emergencies poor characteristics are dangerous They impose unnecessary loads on the airplane structure and lead to inefficiency in maintenance and in structural weight It is easy to see the value of an airplane, from the passengers' standpoint, which does not pitch, roll or yaw excessively or unnecessarily, but the effect on commercial reliability is even more important and less obvious Reliability in the future will depend on blind flying, and how long could the average transport pilot today fly blind on the average multi-engined plane with one outboard engine stopped? Today it seems to be the function of instruments to enable the pilot to do with the plane what the plane ought to do for itself Consider, for example, the difficulty experienced, and concentration required to hold some planes on a really steady compass course There is good reason to fear that the advent of the automatic pilot will provide some designers with an excuse for taking less care in control design, since the automatic pilot will be expected to compensate for any control condition with accuracy and without complaint It is obvious that the better the flying qualities the less work will be thrown on the automatic pilot, the more accurate and reliable it will be, and lighter loads will be thrown by the instrument on to the structure

There are certain characteristics which should be common to all types of airplanes Stability should be positive in every direction, though the degree may vary Controls, whether balanced or unbalanced, should have the characteristic of the unbalanced control, namely, the tendency to trail perfectly in all normal manoeuvres This last requirement is certainly unsatisfied in many balanced controls, for example in the highly balanced rudder of low aspect ratio Such a rudder tends to be extremely light at small angles, becomes rapidly very heavy as it is pushed over, and again becomes very light as the fuselage yaws in response Where this occurs, especially in big planes, the rudder may be operating the pilot a good part of the time with very fatiguing effect

Control

A control of perfect "feel" can be defined as one which, *under all normal manoeuvring conditions*, gradually becomes heavier as the control is moved over, while never becoming too heavy From this it follows that, whenever released, the controls should return accurately to centre.

In the fighting plane the controls must always be light enough and powerful enough to overcome easily the normal stability Thus however is no excuse for dispensing with normal stability, as is frequently done In the observation or commercial plane, where straight cruising is the normal requirement, control should be less powerful in proportion to stability In the bombing plane much study should be given to the possibility of maintaining an extremely

straight course for purposes of sighting, for the controls must not yaw the plane except where yawing is intended

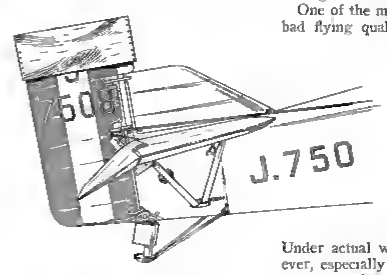
In pursuit planes controls can hardly be too light, if they satisfy the self-centering requirements. On the large transport plane aileron lightnesss should increase with span since, with large span, the ailerons may be called on for more work, and are less able to disturb the plane too suddenly. Elevator lightness should be in proportion to longitudinal stability for both structural and piloting reasons. Obviously a barely stable plane might be structurally overloaded through too light an elevator. On the other hand, with great longitudinal stability and a heavy elevator the pilot would have too much work in maintaining trim under sudden changes of condition Rudder lightness (always maintaining the centering tendency) can hardly be excessive in a large plane. For one thing, both fuselage and wing inertia tend to oppose excessive motion in yaw during momentary over-use of the rudder For another thing, the pilot's feet are usually less effective than his arms. Particularly in multi-motored planes on the failure of an outboard motor, especially when flying blind under such conditions, the rudder may be called upon to work more or less normally in an already biased condition. This may mean of course that the pilot can cause passenger discomfort by over-use of a light rudder, but in practice, it is largely a question of getting used to it

The use of the servo-rudder (a small rudder mounted behind and operating the main rudder) is more common in Europe than in this country It solves a great many rudder problems

Requirements for private planes

In the plane for the private flier general agreement has not been reached as to just what is required. An airplane of this sort should be inherently stable, with controls carefully proportioned so that the pilot is barely able to overcome the natural stability in normal flight For example, the longitudinal stability and control should be so related that if the stick were pulled full back under normal flight conditions the elevator would be insufficient to stall the airplane In the case of a forced landing, a complete pull back on the stick would merely result in gliding into the ground It should be possible to design such a plane and still have all the maneuverability reasonably required As things stand at present, however, it would be difficult to get such a plane past the old time pilot and his successors, who instinctively demand much more control than such a plane would give In other words, they demand enough control to enable the unskilled flier to get himself into trouble.

A great deal of research work has been done on various kinds of controls with their forces, moments and loads This research however, has been valuable chiefly as a basis for original design A control design, however, which will operate in one manner on one type of plane will operate quite differently on another, owing to the large number of variables which enter into the problem The perfection of the controls is almost invariably an empirical matter, and it is highly desirable in the design of a new type of plane, that all possible allowances be made in the construction of the first plane for changes in the control system. In any new type, except with amazing luck, the best control proportions can be reached only by trying different areas, shapes and gear ratios by a pilot with real experience in causes and effects. Sometimes troubles arise from the application of ideas which have proved good in other airplanes Take the case of the Frise type aileron. Any reasonable use of this type is bound to give a light and powerful control with reduction of positive yaw, but this is frequently overdone In a certain well known machine the Frise ailerons when new give a light and powerful control, but after a little use, friction develops in the control system The ailerons are so highly balanced to begin with that there is only the barest tendency to return to centre which is overcome by the increased friction, and the ailerons do not return to centre unless they are



A test rig for checking rudder balance. The plywood envelope clipped over the top of the rudder may be moved up or down to change balance area without changing rudder structure.

definitely put there The effect is almost the same as if the plane were laterally unstable or out of true Similarly, the differential aileron is frequently misapplied

Theoretically excessive fixed fin area can be a source of trouble since bumps can cause the fin area to yaw the machine about. In practice, however, this does not occur if the rudder design is correct, since the pilot can then adequately deal with the case For a given total fin area the rudder surface should be as small as is adequate for control purposes, and the rudder chord as small as structural considerations reasonably permit. This, in practice, works out at plenty of fin area and a high aspect ratio rudder These remarks, of course, apply mainly to large planes The amount of rudder control increases with the necessity for maneuver ability.

Apart from those matters which have to do with control design, there are many other characteristics which must be taken into account in the early stages of design, since little can be done about them once a plane is built One important factor is the engine arrangement Almost all high wing monoplanes suffer from a tendency to drop the nose when the engine is cut out Several planes are in common use where this drop of the nose could be actually very dangerous in emergencies This is the natural result of a low thrust-line which can usually not be raised in this type without obscuring the pilot's view This can be overcome only by placing the centre of gravity further aft and increasing positive tail angle. This, however, leads in the direction of instability Conversely, most difficulties introduced by high thrust-lines can be met by increasing the stability The chief loss here is in negative lift on the tail which is the equivalent of adding structure weight. In general, however, a higher thrust-line leads to improvement in flying qualities which is one of the advantages of the low-wing arrangement.

One of the most common examples of bad flying qualities is the difficulty in controlling a multi-engined plane with an outboard engine stopped In many cases, on "test" and demonstration, such planes have flown beautifully with one engine cut by the exercise of great skill and brute force on the part of the pilot Under actual working conditions, however, especially in low speed and emergency conditions, cases have arisen where tri-engined planes, with a ceiling of some 10,000 ft. on two engines, have been forced to land after the failure of one engine merely because the pilot was unable to maintain control Flying blind under such conditions seems almost absurd

In many multi-engined machines it is practically impossible for anyone but a super-pilot to be definitely counted on to handle the plane correctly in case one engine suddenly cuts just after taking off. The difficulty of control under the circumstances is increased because the plane has usually swung appreciably before the pilot can analyze the situation and bring into play the extra force required for control Following a bad crash from such a situation in 1919 the

author has always made it a practice to keep one hand on all the throttles until well clear of the ground (any plane ought to be perfectly easy to fly with one hand), and in the event of failure to cut all engines, giving a second or so (which is a long time under the circumstances) to think the situation out, then putting on the engines again if necessary. If the engine distribution and the rudder control is such that the pilot knows that excessive effort is not required to keep the plane straight, some of the danger is eliminated. There is no real reason why a tri-engined plane, on the failure of one outboard engine, should not be almost as easy to fly as it was before. This situation, moreover, should be taken care of by the controls themselves and not by the setting over of the fixed fins, since such surfaces would have to be readjusted for every change in air and engine speed. Adjustable fins may be a help, but the ordinary rudder control should be fully capable of dealing easily with any condition arising from engine failures at any speed. The absence of such qualities in so many airplanes is a fair example of the lack of study put into the design of the flying qualities of the modern plane. One result has been to strengthen the case for the single-engined plane for transport work since, it is argued that the multi-engined feature increases the risk of engine failure and apparently provides no compensating safety.

Passenger transports

The passenger transport plane offers an interesting field for the study of flying qualities. While economy and safety are essential, passengers must have space and comfort, and the pilot must have the minimum amount of labor under any conditions. Light wing loading makes for safety, but the resulting large area appears frequently to lead to control and stability troubles which careful study could avoid. Lateral stability can easily be excessive leading to too much rolling. The author is inclined to disagree with Mr. Breguet's idea that passenger discomfort arises mainly from vertical oscillations of the centre of gravity. It is certainly true that these movements can be the most violent, and that they increase with higher speed, but they correspond closely to motions which the ordinary traveler is accustomed to in ordinary ground transportation, for example in a fast automobile. They do not appear to have the same effect on the passenger's stomach as the other motions, which more nearly correspond to those motions of a boat which produce sea sickness.

For comfort, passengers must be grouped as closely around the centre of gravity as possible. Moreover, the best flying qualities will be obtained where all other concentrated loads such as engines and tanks are similarly grouped. This usually means that the passengers' view is obstructed either by the engines or the wings. Some designers meet the problem by placing mail compartments and toilets around the centre of gravity and stringing passengers out through the length of the fuselage. The resulting passenger discomfort is too high a price to pay for the better view. This is really an unimportant factor even today, and will become more so as passengers cease to be joyriders and become travelers.

Too little lateral stability may require too much work for the pilot. It should be just sufficient so that in medium rough air the rudder alone can maintain lateral trim without too much side slip. Longitudinal stability can, within reason, hardly be excessive. Very great longitudinal stability helps almost every flying characteristic from the take off to the landing. It can be used also to reduce structural weight, though unfortunately the present government requirements do not permit this. Those who remember the old war time FE 2, which it was quite impossible to hold in any sort of a dive, will know that such great stability prevents the pilot from throwing excessive load on the structure under all reasonable circumstances. Government requirements at the moment require the strength of the body to be in proportion to the tail area which is a direct incentive to constructors to reduce longitudinal stability to the minimum.

Blind landings of the future will be accomplished by direct glide into the ground with suitable landing gear. Thus again demands great longitudinal stability, enabling minimum speeds to be maintained without danger.

Directional stability is closely bound up with lateral stability and can be excessive for similar reasons. It is however a complicated problem, being further elaborated by requirements of flight with one engine cut. This is a typical example of a problem which can be dealt with only by empirical investigation. It is not a difficult or expensive job to try out various fin and rudder combinations but it must be done properly.

Yawing, like pitching, can be very uncomfortable to the passenger, the discomfort increasing the greater distance from the centre of gravity. Where longitudinal stability usually affects the pitching only, directional motions introduce the rolling factor, and a transport plane which is poor in directional stability will proceed through the air with the combined roll and yaw usually associated with drunken sailors,—probably the most uncomfortable motion which can be given to air passengers. This happens sometimes on planes where the wind-tunnel tests show adequate stability. In such cases it will usually be found that the rudder area is too large in proportion to the total fin surface, or the rudder chord is too great for the effective control effort of the pilot. As a result, in calm air stability is satisfactory, whereas in rough air, bumps tend to take partial control of the rudder. After a time the pilot gets too tired to maintain steady motion and allows the plane to weave along in the general direction of its destination.

Landing speeds

The consideration of landing conditions brings up many points of interest. Landing speeds should form the basis of almost every comparative estimate of the characteristics of a plane because so many things can be helpfully added or subtracted if landing speed is left out of account. What is landing speed anyway? Although not the conventional definition landing speed is really the speed at which an airplane must approach the field in order to level off for normal landing. For example, for two airplanes having the same stalling speed but different gliding angles, the one which has a steeper glide will have the higher effective landing speed. Thus takes into account the control and stability factor, for obviously a plane with poor low-speed control and stability must come in faster. Actual contact speed does not mean much since it is the distance required for landing which is of practical importance. The above definition is open to some criticism, since the plane with a steeper glide would have a proportionately higher drag and therefore a quicker pull-up, but it does cover more of those general flying characteristics which are associated with landing. It also covers landing-gear structural requirements since, with adequate landing gear, the minimum gliding speed can be the landing speed.

Landing speed estimates based on wing loading and lift coefficients can also be misleading. A plane with the propeller disk in front of the wing can lose considerable lift by the interference of the idling propeller and would thus have to land faster than a plane with similar wings but without such interference.

There is a widely held fallacy that the extra lift obtained when a low wing is near the ground reduces landing speed. This really is of no practical advantage, and may even be detrimental. The extra lift from ground interference cannot take place when the plane is coming in to land and can therefore in no way reduce the speed until the plane is very close to the ground. When it does take place, the plane can be said, for all practical purposes to have landed, the only difference being that it runs for some distance on a cushion of air instead of on the wheels. This false lift actually reduces the speed at which the wheels touch the ground, but this has only the minor advantage of relieving the landing gear of certain loads. It can not decrease the landing distance required. On the contrary, it will probably increase it since it will delay the moment where the brakes or a steep ground angle can come into play to slow up the plane. Another popular misconception concerns that characteristic vaguely know as "floating." A plane is said to "float" when, after getting near the ground, it continues a long way through the air before it touches. "Floating" has been attributed to all sorts of mysterious characteristics in the wings, or their stalling qualities, but it is nothing more or less than an indication of bad control at low speed. Low speed control being poor, the plane is compelled to approach at a speed considerably above its stalling speed. When it gets close to the ground it has to remain there while that excessive speed is lost. This point frequently arises when a plane, which lands easily with a full load, is found difficult to land with a light load.

Whatever the design, the pilot's position should be as far forward as possible (except possibly in certain flying boat cases). If the passenger grouping requirements are met it will follow that the pilot will not be too far forward to be over affected by yawing and pitching. It is an open question whether it is possible to put the pilot too high up on large planes, thus impairing his landing judgment, but this is not of importance in transport planes where skilled pilots rapidly become accustomed to height off the ground. In the private plane, however, the ordinary pilot is very greatly assisted in landing by being as close to the ground as possible, a consideration which may gradually lead to the adoption of the pusher type of airplane for private use.

Judging from recent discussions, the attainment of good control at low speeds seems to be greatly overrated as a difficult problem. Much effort has been expended in trying to get control *below* stalling speed, which is a waste of time. Whatever success may be attained in that respect, the fact remains that flight below the stall involves a high vertical speed, which introduces almost the same troubles which have been avoided by reduction of forward speed. That is why, in spite of a long period of development, slots and flaps are not in general use. They will come into use when cleaner and more efficient design will render gliding angles so flat as to necessitate some form of air brake. The slot will then provide the steeper gliding angle required and at the same time reduce the forward speed. Incidentally such planes will probably have thin wings in which the slot is more effective.

When the reliability of engines and operation methods improve sufficiently so that airplanes need never be expected to land outside of their scheduled airports, landing speeds can be safely raised, but at the present moment safety demands the lowest landing speeds reasonably possible.

The expression "flying characteristics" covers a large number of factors which are difficult to define in an engineering sense. They are so bound up with the general design of the plane that the best results can be obtained only where extensive analytical flying experience is used in cooperating with the engineering design. Unfortunately, flying qualities are too often investigated after the engineer has finished his job. It is significant that planes noted for their flying qualities are almost invariably produced by firms in which the governing individual is a thoroughly experienced pilot, or one who knows enough to give a real test pilot his proper status in the engineering organization.

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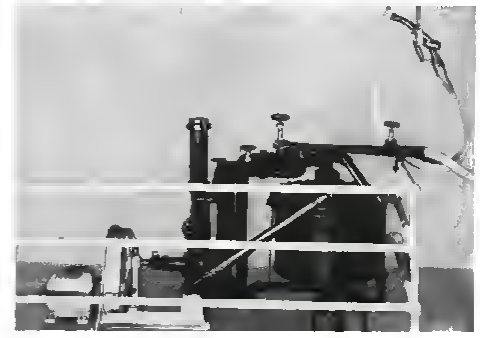
Removing water from gasoline

A segregator adopted by the Air Corps



Type R-2 segregator (the tub-like unit) for underground gasoline storage tanks. This unit has an outside diameter of 22 in. and capacity of 45-60 gal. per min.

THE Air Corps has adopted as standard equipment, after many months of experiment with the device, the automatic fluid segregator invented by Master Sergeant David Samiran for removing water from gasoline. The segregator has not yet been made available for commercial aviation, but Army experience with it indicates its potential value to commercial fields.

The device consists of six main parts: a cylinder which forms a chamber, a deflector, valve assembly, valve guide and sediment screen approximately as deep as the chamber. The operating principle is based on the natural tendency of water and gasoline to separate, due to difference in specific gravity.

Within the body of the segregator is fitted a float, the specific gravity of which is slightly greater than that of the fuel to be filtered. When some liquid, such as water, whose specific gravity is greater than that of the fuel, finds its way into the segregator, the float rises, opening a valve in the bottom of the chamber and releasing the undesired fluid.

Fuel is drawn off through an opening at the top of the chamber and is then passed through a sediment screen. Incoming fluid is delivered at the bottom of the chamber with a minimum of turbulence. By suitable adjustment of the weight of the float, the device may be made so sensitive as to discriminate between hot and cold water, or between two grades of gasoline whose difference in specific gravity is as little as 0.01.

There is practically no limitation to the size of the segregator. Models have been built for installation in airport pits, on tank trucks, on fuel systems, of planes and motor boats, and one is so small it can be placed easily in the pocket. The first model was demonstrated at France Field in 1925. Sergeant Samiran has been working with the device since 1928 as a member of the Experimental Engineering Section at Wright Field, where he hopes to be able to continue his experimental work.

Prophecy for 1932

By Edward P. Warner
Editor of AVIATION

The reputation of prophets in general is at a low ebb

FOLLOWING the precedent established a year ago, I have to lay aside for a time the discussion of current events and undertake to foresee the future. My personal forecast for the next year is due. Its preparation is an undertaking from which one might well shrink, for seldom has there been so much difference of opinion about the immediate prospects as there is now. Seldom has there been so keen a desire for optimism and for encouragement, and it is extremely difficult to keep one's balance and to regard the facts of the economic situation with due conservatism and without prejudice.

The reputation of prophets in general is at a low ebb. The layman has come to be extremely sceptical of all economic forecasts, and to believe that they could be made just as accurately by shaking dice as by the most exhaustive study of charts and analyses of statistics. Volumes have been published for the sole purpose of celebrating the errors of the prophets and of demonstrating the spectacular unanimity and completeness with which the most distinguished among them have been wrong about the major economic developments of the last two and a half years. To undertake a forecast now in any branch of industry (and nowhere is it more difficult or risky than in aviation) is to invite a chorus of derision.

Nevertheless the attempt must be made by someone. Every transport operator must have some idea of the probable development of his traffic, in order that he may plan properly for equipment and physical facilities. The manager of a flying school must hold some opinion on the number of student permits likely to be issued in the next few months, and on the proportion of them that will represent prospective applicants for formal instruction. The builder of airplanes or engines or accessories must base his production schedule on a very careful examination of the possibilities of his market in the near future. Every one of them is bound to engage in anticipation of the possibilities of his own particular business, and I take it as an obligation of the editor of an industry paper to furnish a general and detailed discussion of the prospects, a discussion which each individual in the industry can supplement with his own more specific estimate of his own particular situation.

So I undertake the task, endeavoring to hold the scales as level as possible and to guard at once against that unreasoning and over-sanguine enthusiasm which has often beset the industry and against any undue pessimism engendered by the innumerable stories of misfortune and despair that the current depression has produced—not, by any means, all of them in the aeronautical field. Forecasting that is based on hopes or fears is of no use. It has to be undertaken, if it is to be of service, with a perfectly open mind and with no object except to get at the facts and to follow them wherever they lead.

Transport flying

As 1931 draws to a close transport activity is steadily increasing its dominance of the aeronautical industry, or at least of its non-military section. The amount received by airlines in the United States for carrying mail, passengers, and express during the past year has been almost three times as great as the gross sales of non-military aircraft. It has been three or four times as great as the total of all "aerial service" operations, including instruction. In 1929 on the other hand, the value of the new production was at least double the total of transport income. It seems likely that the lead of transport flying over the other branches of the industry in economic importance will continue to grow. Other branches have had their ups and downs. They have been through booms and they have suffered checks, but transport activity has moved steadily forward. It will continue to do so.

My transport prophecy for 1931 [AVIATION, January, 1931, page 13] came out reasonably well. It showed an underestimate of about 10 per cent in mileage flown, and an overestimate of about 30 per cent in passenger-miles. The major error was in figuring the density of passenger traffic on the air mail lines. The present indication is that the total American-flag mileage (including that of American-controlled air routes in South and Central America and the Caribbean) in 1931 will be 46,000,000 and that the number of passengers will average just over two on the mail routes and just over three on those having no mail contracts. For next year no substantial increase in mileage seems likely. The volume of operation with air mail is fixed by the appropriation allowed the Post Office Department and the budget estimates show a reduction of $1,000,000 from this year in that figure (including both domestic and foreign mails). With a further slight cut in unit compensation, the money provided will just about take care of the routes already established. At the present time air mail operations are at the average rate, allowing for the normal percentage of mileage not flown because of weather, of 35,500,000 miles a year. I take that as a probable figure for 1932.

Transport operations without mail and without government support have totaled about 12,000,000 miles in 1931. At present they are running at the rate of about 14,000,000 miles a year. Some new lines will be established during the new year, and some will increase the number of their schedules, but others will close down either because of financial difficulties or because they were started in the hope of getting mail contracts and discovered that the hope cannot be fulfilled. At least one or two new high-frequency services should be started, particularly in the central part of the country and in the south. I estimate a probable mileage without mail in 1932 of 13,600,000.

The tendency towards moderately small planes, likely to be at least as conspicuous next year as this, would tend to decrease somewhat the average number of passengers carried per plane, but that will be offset, particularly on the contract-mail lines, by a generally increased acceptance of air transport, by the results of improving traffic solicitation work, and by the more general use of good passenger-carrying equipment on the mail runs. I anticipate an average of 2.7 on the mail routes and 4.0 on the routes operated without mail. Multiplying those figures by the estimates of mileage flown leads to a predicted total of 150,000,000 passenger-miles, about 25 per cent in excess of the current year's figure. Average passenger fares per mile through 1932 are likely to be down about 5 per cent from the average for 1931, and the increase in total passenger revenue to all the transport companies should therefore be about 20 per cent, or just over $1,250,000, to counterbalance a drop of $1,000,000 in postal revenue. The total operating income will remain about $35,000,000.

It is time that we stopped using 1926 or 1929 as points of comparison

The revenue of the Post Office Department from air mail will of course continue to increase, and the net expenditure on air mail, or contribution to the Post Office deficit, will be reduced by considerably more than the $1,000,000 to be cut off the expenditure. The total weight of mail dispatched by air in 1930 was 14 per cent larger than in 1929, and 1931 shows a gain of almost exactly the same magnitude over 1930. I look forward to a continuance of substantially the same rate of increase, or possibly a slight slowing down, with a total weight of mail handled of about 10,000,000 lb in 1932. In traffic units that will probably represent about 2,800,000 ton-miles.

There has been great excitement over air express in the last few months, and undoubtedly that type of business is capable of notable development. Undoubtedly, also, the recent reduction in air express rates by the Railway Express Agency, a reduction averaging over 50 per cent, will be a great stimulus to traffic. I expect 100 per cent increase or better in air express, bringing the total weight handled on domestic and foreign lines to about 1,800,000 lb. Again converted to the standard traffic units, that should represent about 240,000 ton-miles, or approximately one-tenth the volume of air mail business. These figures of course neglect the special case of the company freight carried on the Ford-operated planes out of Dearborn, and apply only to the airlines doing business with the public. Of the total operating income of $35,000,000 already suggested as a possibility, $26,000,000 should come from air mail (both domestic and foreign), $9,000,000 from passengers, and about $300,000 from express.

That unpredictable and volatile factor, the private owner.

A transport boom coming?

A year ago I had hoped that 1932 might be the year of great expansion in air transport. It is sure to come, but it appears now that it will be postponed at least until 1933. We shall have in due course a two or three-year period of very rapid development in transport activity, but it will not be until there is some apparent upturn in general business conditions, nor until transport operation costs can be consistently cut down to 30 or 35 cents per ton-mile of capacity. A few favored operations already report having attained the higher of those figures, but 60 to 70 cents would be a fair general average at present. To catch the average business traveler or tourist in really great numbers, fares must be dropped to around 5 cents a mile.

Fixed-base operation in its various phases, is suffering from a variety of handicaps. It is affected at every point by the world depression, as is everything else. "Hop-flying" has shown a natural tendency to slow down with the decreasing novelty of aviation and with the general availability of transport lines, permitting the man with an urge to fly to work it off in going somewhere instead of merely taking a trip up into the air and down again. It is not by any means extinct, and in localities of special scenic interest it will remain an important factor in fixed-base operations, but it is likely to show some further decline over the next two or three years. Taxi-flying and special charter work have also been injured by air transport development, since the traveler who can do so naturally elects to take a regular airliner at 6 cents a mile, rather than hire a special plane at ten times that figure. In addition to that they have suffered with peculiar force from the depression. The habit of chartering airplanes is one of the first things to be cut off in times of financial distress.

Of all aerial activities, the long-term outlook is brightest for survey and photographic work. In spite of diligent promotion by two or three firms the field has by no means been fully exploited, and any upturn in general business activity ought to bring about a very marked increase in the volume of photographic work. It is impossible, however, to look forward to that with any confidence for the coming year.

Student prospects

Last among the fixed-base flying activities is instruction. It really divides into two classes—the kind of teaching that is given by highly-specialized and elaborately-equipped schools, usually operating under Department of Commerce approval, and the kind that is offered by a small local operator to residents of his own neighborhood, giving instruction on the same planes and with the same pilots that do his miscellaneous passenger flying. Much of the latter sort of instruction is so informal that it is impossible to get statistics on it or to make any estimate of its volume. The former type, that of the specialized transport school, may face some reduction in number of prospects during the coming year, but there will still be plenty of students to keep a few really high-grade schools going smoothly.

To be specific, the number of student permits issued has dropped from 18,600 in 1930 to approximately 15,700 in 1931. I anticipate a further drop for the coming year, but not nearly so large a one. I estimate the total permits to be issued at 14,500. This of course includes renewals of old permits, as no distinction is made between the original issues and the re-issues in reporting the statistics. Of the 14,500 I reckon that about 9,000 will be issued to people who will take some sort of instruction with the serious intention of sometime learning to fly, while the remainder will go to individuals who for one reason or another want to be free to handle the dual control in a plane without infringing the law, or whose enthusiasm chills between the point of taking a

permit and the point of starting instruction. I anticipate that about 3,600 of the new permit holders will enroll in regular schools (of either of the two classes mentioned above) and seriously pursue classes designed to lead them directly to their pilot's licenses

The number of licensed pilots will of course continue to increase, though probably not at quite such a high average rate as during 1931. At the end of 1931 there will be about 17,800 licensed pilots and about 13,000 valid student licenses outstanding. At the end of 1932 I estimate the corresponding figures at just over 20,000 and about 12,000

Production outlook

All this will require airplanes, including a certain number of machines of new production. The amount to be expended on new machines for civil use is, of course, small compared with the total of purchases for the Army and Navy. The Federal Budget for the fiscal year 1933, as analyzed elsewhere in this issue [page 7], offers a total of $18,376,000 to be obligated for new flying equipment for the Army and Navy, a decrease of 31 per cent from the amount appropriated for the present year and 40 per cent from that of the preceding year. The cut from the amount actually being expended this year is about 22 per cent. It is, or will be if Congress does not raise the figures allowed in the Budget, a very serious setback. Practically all of the purchases represented by that sum will of course be distributed among the six or eight companies that are recognized as constituting the "military industry." The same group have another source of income in the export of military planes, mostly to South America and Asia. Shipments of that class will run from 60 to 80 planes in 1931. They are likely to be about as large in 1932, offering a 15 per cent addition to the income derived from the military purchases of the American government.

All of the other manufacturers of planes and engines will have to get their customers out of the much smaller sum that goes into the purchase of planes within the industry itself or for the use of private or industrial owners.

Transport demand

In predicting production a year ago, I over-estimated rather badly the number of new machines that would be consumed by transport lines. It was my assumption that the number of new planes needed for replacement of ordinary wear and tear would be considerable. Experience has shown that there were very few replacements. At the present time it is the popular assumption, at least among those not engaged in transport operation, that the replacements avoided in 1931 will be made in 1932 and that next year's demand will be heavy indeed. In personal investigation at the headquarters of many of the transport lines I have found little to instill confidance on that point. Transport operators would like better equipment than they have at present, more economical, more comfortable for the passengers, faster, and easier to maintain, but until they see some very marked improvement over present standards most of them intend to continue the operation of what they

Is it receding?

already possess. In spite of the fact that most of the machines now in service will be three years old during the next year, and many of them four, replacements seem likely to run only about 22 per cent.

The data available for forecasting on transport demand now are much superior to those of a year ago. At that time there had been no study, such as was subsequently made for and presented in the statistical issue of AVIATION, of the classification of machines then in transport service by the date of their manufacture. However, date of manufacture is proving not to be the determining point in fixing time of replacement. Many operators have in mind an ideal of their own for equipment, in some instances far ahead of the present state of the art. Until it is realized, or at least approximated, they intend to continue to keep their present planes in service, rebuilding them as often and as extensively as necessary.

I conclude that transport operation will call for 240 new craft, 140 for replacement and 100 for new services. Out of that total I forecast approximately an even division between multi-engined types, or very large single-engined machines accommodating at least seven passengers in addition to the pilot, and smaller and faster planes, usually for five or six passengers.

The demand for very high speed seems likely to continue. It is one with which I find myself in only very limited sympathy, but I anticipate that it will go on at least for a time, and that a very large proportion of the machines bought for replacement next year will have cruising speeds of 135 m.p.h. or better.

Two of the main categories into which the aircraft market is divided, the "industrial" planes and the purchases of the fixed-base operator, offer only very limited prospects for next year. Non-aeronautical industry, except for certain branches of the petroleum business and certain other lines in which the airplane has come to be recognized as a virtually indispensable tool, is slow to lay out money on aircraft, or anything else that presents novelty and involves expenditure, in a time of general depression and shrunken earnings. Aerial service operators will buy new planes, to a total number which I am inclined to set at a little over 100, where they need very specialized characteristics that they can find only in one or two designs. For general service, under present economic conditions, they are more likely to replenish their stock from the used-plane market.

Private ownership

Finally there is that unpredictable and volatile factor, the private owner. As in the two years past private ownership in its various forms continues the most promising outlook, at least if the numbers of ships sold be taken as a measure without regard to their individual value. A steadily growing number of business men and sportsmen are finding the airplane at once attractive and useful, and are deciding, even in the years 1931 and 1932, on putting the necessary amount of money into its purchase. There is nothing spectacular about their purchases or about their use of the airplane after they have it, but they are laying the soundest possible foundation for a growing manufacturing industry. Their number for next year might be as low as 300, or it might be as high as 3,000. After rather careful analysis of the record of recent sales and the other data available in several sections of the country, I am inclined to set it at 1,000.

The total of assumed non-military production then runs to 1,440 planes, about 25 per cent below that for 1931. As will develop shortly, however, the assumed reduction is almost entirely in a single type of craft, the so-called light plane. The gross value of civil and military production, including the spare parts for military purposes purchased from maintenance appropriations should attain about $28,000,000.

Since no manufacturer makes all types of flying equipment, every manufacturer is primarily interested in the division of total production among classes and sizes of planes, and in the allocation to his particular group. The 240 transport purchases will of course be almost entirely machines of six-passenger capacity or more. There is

still a great deal of feeling in transport circles in favor of much larger planes, but in my opinion that school of thought will not show much effect on production in 1932. I foresee the typical transport plane of the coming year as having a total of between seven and eleven seats, and of the total purchase of 200 machines I prophesy that there will be 95 with from eight to eleven seats (or an equivalent capacity in mail or express), 70 with six or seven places, 30 with less than six seats (for night mail operations and feeder lines), 25 with more than eleven, and 20 amphibions or flying boats.

Private owners and light planes

To break down the private market is far more difficult. In my article of a year ago I predicted 500 light planes for the 1931 crop. That prophecy was made the subject of some very heated criticisms by light plane builders and enthusiasts who wrote to tell me that the actual production would be at least 3,000 and perhaps much more than that, but as a matter of fact it proved to be the most accurate element in my forecast. The actual sales for the year are very near 500, possibly 10 or 15 per cent over, if purely amateur construction be eliminated from consideration and if those planes which are still at the factory or in "dealer's stock" be omitted.

At the present time the market for light planes seems, at least temporarily, to have approached saturation. Furthermore, certain of the leading manufacturers of the type have discovered that there was no profit in it for them at the price that the market demanded and with the limited production that the market invited, and have withdrawn from the field. The light plane is not by any means in danger of extinction, for it renders a very definite service, and there will continue to be a demand for it. The demand will, however, be quite limited, and in my judgment more restricted in 1932 than during the wave of enthusiasm that attended the introduction of many examples of the type in 1931. I am setting the total of probable production of light planes for the coming year at 165. This of course refers to factory production only, and excludes the machines built by individuals for their own use.

As in the past, but I believe more than in any previous year, most of the private market will distribute itself between the two or three-passenger open machine, usually a biplane in present practice, and the four or five-passenger closed type, usually but not by any means always a monoplane. I anticipate that more than half of the total production for private buyers will go into those two groups.

Amphibions

Next to the light planes, perhaps the most confusing problem is presented by the estimation of the volume of demand for amphibions and flying boats for private-owner use. Last year I very seriously overestimated that demand, but I conditioned my forecast upon two factors: first, that there should have been some improvement in general business conditions during 1931; second, that a really vigorous attempt should be made by several manufacturers to promote sales among yachtsmen. There has been no upturn in general business, and the sales effort on amphibions has been limited by shortage of funds and otherwise. Production and sales during the past year have been distressingly small.

We cannot look forward to very much benefit for the market of this type of aircraft during 1932 from any change in the general economic position. Even though we should have reached the end of the depression and started on the upgrade, recovery will be slow enough so that there will be little encouragement to what most men would regard as a luxury expenditure during the coming year. However, I see a new possibility in the production of amphibions of light weight and low cost, perhaps at materially lower prices than any that have so far been built, and I am very hopeful for a considerably larger production of marine aircraft in 1932 than during the past year.

Finally, my anticipations for production can all be summarized in a table.

Landplanes

Number of seats*	Open	Cabin	Total
Light planes			165
1–3	250	110	360
4–5		365	365
6–7		250	250
8–11		110	110
12 and up		35	35
Total			1 505

Amphibions and flying boats

1–3	70
4–6	30
7 and up	35
Total	135
Total estimated production	1 440

*Number of seats (including pilot) or equivalent payload in machines designed exclusively for express or mail service

It will be noted that nothing has been said about autogiro prospects. It is almost impossible to prepare a forecast there, as the acceptance of any device or vehicle of comparatively novel form is peculiarly sensitive to the whims of public opinion and to general business. However enthusiastic men may be about a new idea, they are slow to spend money on it when money is hard to find. The principal autogiro market of 1931 has been among national advertisers. The great potential market of the future is among private owners. If the general outlook grows materially brighter in 1932 there might easily be 300 to 500 private-owner sales, especially if it should prove possible to develop models at substantially lower price than have so far been standard. If, on the other hand, business continues uniformly bad through the coming year, the autogiro market is likely to be a very restricted one—though, even so, the total production should run well ahead of 1931.

Looking farther ahead

Though it is quite perplexing enough to undertake a forecast for a single year, the effort ought not to be brought to a close without at least a general look farther into the future. I have already expressed my conviction that within a few years, probably in 1933 or 1934, air transport will begin a period of rapid expansion and progress to complete independence of any support by the Post Office Department. Unless there be some radical innovation in design, which cannot at the moment be foreseen, I do not anticipate any corresponding sudden acceleration of aircraft production.

Transport demand will of course be responsible for a considerable growth in the volume of manufacture, and especially in the total value of planes produced. The steady trend towards more intensive use of equipment, however, brings about a reduction in the number of new planes that have to be purchased for transport service. At the present time transport operations run about 160,000 miles per day. Within the next six or seven years I believe that they will pass 1,000,000 miles a day, but by that time a thousand miles daily operation for every plane is likely to be commonplace. Only about 1,000 planes, or about 60 per cent more than are now in service, will then be needed to take care of the vastly increased volume of traffic. The manufacturing industry was built up on the expectation of a vast private demand, and if there is to be a large and rapid increase in output, it must come as the result of an increase in the private consumption of aircraft.

There will, however, be a steady increase in production, accelerating with our return to a more normal economic status. It is time that we stopped using 1928 or 1929 as points of departure or of comparison. We have enough perspective now to regard those years as wholly exceptional, as a period in which the industry was selling its products largely within its own circle, and with very serious over-production of certain types. We have not yet entirely escaped the influence of that over-production, but we are rapidly getting out from under it. I believe that the American industry will be back to a gross annual non-military production of $30,000,000 to $40,000,000 by 1936 at the latest, and quite probably by 1934. We may reasonably hope that we shall be fortunate enough to avoid any sudden boom, with its equally sudden and violent reaction. But we can look forward to steady progress.

Left: The Blackburn Iris powered with three Rolls-Royce Condor engines, a prominent type in British flying boat patrol squadrons

U. S. Navy

Above: The Wright Cyclone-powered PN-12, a product of the Naval Aircraft Factory

U. S. Navy

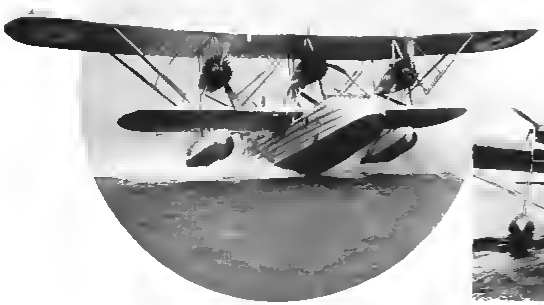
Above: The Martin P3M-1 flying boat developed for the U. S. Navy powered with two Pratt and Whitney Wasps

Below: The latest Supermarine Southampton design (three Armstrong Siddeley Panther engines)

Flight

Above: The new Short Singapore II with four Rolls-Royce Buzzard engines in tandem

Below: The Blackburn Sydney (an experimental monoplane design (three Rolls-Royce FXII engines)



The Aeroplane

The military significance of a type of aircraft which may in the future assume paramount importance for maritime nations

Flying men o' war

By Maj. Oliver Stewart
M.C., A.F.C.

MILITARY flying boat development varies markedly both in extent and in direction in the different countries showing interest in the type, for the value of the boats to an air force and the way in which they would be used depend upon the geographical situation of the country and upon the manner in which its territory is distributed.

Recent developments in design and operation indicate that for all nations with large maritime responsibilities—such as the United States, Japan, and the British Empire—the military flying boat, with its enormous unexplored potentialities, is likely to become in the future one of the most important of service aircraft types. If it fulfills its present promise, it will be able to do tasks which no other aircraft or surface craft can perform.

The flying boat must, in the future, take on the duty of defense and the maintenance of war communications where the landplane leaves off. That is particularly important for Great Britain; but a chart of the Pacific indicates that the long-range flying boat must eventually be of equal importance to the United States. It has become a strategic axiom that aircraft form the first line of defense. Flying boats it might almost be added, form the first line of the first line.

Britain as an example

England provides a convenient example. It occupies a central position among many land masses, its coast line relative to its area is long, a large proportion of its food and raw materials is imported by sea. Therefore, if flying is ever to play a part in Britain's military system comparable with that played by the Navy in the past, it must be through the medium of the flying boat. The maritime responsibilities of the United States are equally onerous, and the methods of fulfilling them, owing to the greater range requirements, are more complex. The flying boat must be extensively used in the future if aircraft are to play their full part in the national defense scheme.

Briefly, the functions of the flying boat may be given as: coastal defense and reconnaissance, protection of sea communications and regulation of merchant shipping, cooperation with the fleet and, in some instances, police work. Characteristically it works at low altitudes and covers a wide area, in contrast to the landplane which, virtually confined to circles of 200 to 300-mile radii from its base, works over a small area to a height of anything up to 30,000 ft. or more.

In the machines themselves, wherever they may be used, strategic needs call for three chief qualities: range, seaworthiness and independence. The flying boat must be able to go long distances without re-fuelling; it must be able to alight on and to take off from rough water and to lie at moorings in sheltered anchorages in all weathers, and it must be capable of operating for long periods away from an established shore base. Its seaworthiness must be of the specific kind needed for any type of water on which it may have to operate, whether a relatively short chop is characteristic, as in the North Sea, or a long swell, as in the Atlantic.

Subsidiary requirements are armament in the form of guns and bombs or torpedoes sufficient to allow successful attack against light cruisers and submarines, and a certain capacity for machine-gun defense against attack from the air by aircraft launched from carrier decks or catapulted from cruisers.

The question of range

The range required is dictated by the distances between available bases, measured over the sea. Lakes, rivers and seaports are all available as bases for United States marine aircraft, and the first line of coastal air defense would extend out in the form of a fringe over the Atlantic and Pacific to embrace coastal shipping, as during the World War, when the Navy operated many flying boat patrol stations along the whole Atlantic coast.

Here again England provides an example which throws a light upon American needs. On a route from Great Britain to Africa, India, Australia and New Zealand by sea, the first stage, if foreign territory is to be avoided, must be Gibraltar, about 1,000 miles away from Mount Batten, Plymouth, the nearest flying boat station. The next point is Malta, which is 991 miles further on, and the next Port Said, another 936 miles, or the coast of Palestine, which is about 150 miles more. From there the sea route to Australia is by way of bases in the Persian Gulf to Karachi, Calcutta, Rangoon and Singapore.

If the flying boat is given the usual minimum fuel margin of 30 per cent and is to be able to compass these distances, it must have a still-air range of about 1,300 miles. This is much more than is at present attainable with full military load by standard R.A.F. aircraft, although it is just within reach of the large Supermarine civil flying boat now being built (maximum range 1,300 miles). At present the range of representative British military flying boats is between 600 and 800 miles, according to the load. If two 1,425-lb torpedoes are carried, as they can be under the wings of the Southamptons, the range falls off considerably. British designers, therefore, have some way yet to go.

The range problem before American military flying boat designers is even more difficult. There is, first, the fringe of patrol areas on the coast line already mentioned, which includes coastal shipping protection, and then there are the sea routes between naval bases. The distances to be traversed non-stop demand a range of about 2,000 miles. [The major factor determining range requirements is the ability to operate in the Pacific, and especially

the distance of 2,100 miles between San Francisco and Honolulu — Ed] In every example, therefore, whether drawn from America or Europe, increased range is of paramount importance Among the means being considered for increasing range is the diesel engine with its low fuel consumption.

Among the incidental devices for increasing range is refuelling in the air, which enables the "unsticking" from the water to be done with a small load of fuel Refuelling technique originally developed with relatively small machines, has been expanded by the Royal Air Force especially for use in military flying boats A 1½-in pipe is trailed from the fueling flying boat and the connection is made in the tail cockpit of the one to be fueled The danger of long range operations can be reduced in that way, for a take-off from a rough sea with a heavy load is always a hazardous matter

Seaworthiness

Development is conditioned by seaworthiness requirements no less than by those of range In Great Britain, two-step hulls of ample reserve buoyancy, and with stainless steel bottom plating are employed [Stainless steel plating is virtually unknown in the United States, and single-step hulls have a much larger vogue here than in England.—Ed] Some recent comparative test flights have indicated that float seaplanes might be made to ride better through gales than flying boats, but these trials are not a conclusive guide, and the flying boat is the only type which possesses the general seaworthiness essential for military purposes.

A good deal of experience in seaworthiness can be gained where civil air transport lines employ flying boats for in this type the relation between civil and military machines is close The Kent class of flying boat which is now in service in the Mediterranean on the London-India route of Imperial Airways weighs more than 28 000 lb and is proving seaworthy In high winds it rides better than many medium-sized surface craft. The new Supermarine monoplane with six Rolls-Royce Buzzard engines, to be ready this year, will weigh 75,000 lb with fuel for six hours She has a stainless steel hull and a calculated top speed of 145 m p h

The use of monocoque construction instead of the old main strength frame covered with a thin outer metal skin, together with the methods of riveting hull plates into direct contact in the skin without use of a packing joint, has contributed greater seaworthiness and reduced the damage risk in collisions These steel hulls can be dented without fracturing the skin or causing the plates to spring a leak Machines employing this form of construction have been in constant use for more than three years and show no signs of serious deterioration

British practice demands internal accommodations such that the flying boats many be self-contained and, to some extent, self-supporting There must be chart rooms, bunks for the crew, and kitchens, as well as the usual seafaring equipment with ground and sea anchors and aluminum rowing tenders During flights between England and Australia and England and India, the standard Southampton and Blackburn Iris flying boats have shown they can accommodate their crews in comfort even in tropical climates American craft must be equally capable of providing adequate living quarters in a wide range of climates [The American naval authorities have as yet made no such elaborate demands for housekeeping facilities and American designers have not provided them.—Ed]

Night flying

Night flying is becoming an increasingly important part of flying boat work, still further extending the scope of the type It has been made the object of recent exercises in many countries On moonlight nights very effective observation may be carried out with flying boats and their automatic landing by means of a trailing rod, giving the pilots a signal or actually pulling the control column back when the tip of the rod touches the water, coupled with their ability to navigate accurately, enable them to be flown safely in fog If necessary they can thus be landed on dark nights without the use of lights

The Blackburn Iris has attained a high degree of seaworthiness and the Southampton replacement, which has two Napier engines, carries on the general scheme of the machines that have done most of the R A F long sea cruises All these are descended from the early Felixstowe Fury, with its 135-ft. wing span, which was designed by the late Commander Porte and flown in 1919 It is of interest to note that though the three-engined type has been called for in official specifications, it has not been found entirely satisfactory and is being abandoned for those with two, four and six engines.

Much energy is being exerted in developing the military flying boat in Great Britain because it is realized that only this type can adequately defend the coasts and the trade routes But all that has been done up to the present is only a beginning When the range of military flying boats enables the sea routes to the Dominions to be followed throughout their length, there will be notable changes in the country's system of defense Much of the work that is at present done by the Navy will be handed over to the R A F as patrol in the Persian Gulf already has been, and there will come into existence real aerial fleets, capable of operating over the open sea and away from their shore bases. It is not too much to say that a similar change is likely to take place in the United States, and that there, as well, a vigorous development of the large, long-range, seaworthy flying boat seems to a friendly foreign observer the essential defense need of the moment.

While the concentrated short distance, high-altitude work will probably always be done by landplanes, flying boats will operate over great distances and be responsible for the safety of the world's trade routes. The great air fleets of the future will be flying boat fleets.

Comparison of ten modern military flying boats

Plane, type, and country	Flotation	Gross weight	Useful load	Engines and horsepower	Power loading	Wing loading	Span (ft-in.)	Maximum speed	Normal range
Naval Aircraft PN-12, braced biplane (U S.)	Sponson wing floats	14 415		2 P&W Hornet 1 050	13 80	12 10	72–10	116	1,300
Martin PM-1 braced biplane (U S)	Sponson wing floats	15 766		2 Wright Cyclone 1 050	15 00	13 30	72–10	118	1 200
Consolidated XPY-1, braced monoplane (U S)	Wing floats	13 754		2 P&W Wasp, 960	15 30	12 40	100–00	110	
Short Singapore Mark I braced biplane (British)	Sponson, wing floats	21 000	7,260	2 Rolls Royce Buzzard 1 650	11 75	11 60	93–00	132	910
Supermarine Southampton braced biplane (British)	Wing floats	14 600	5 840	2 Napier, 940	15 50	10 25	75–00	108	
Blackburn Iris III braced biplane (British)	Wing floats	29 000	9 699	3 Rolls Royce Condor 2 000	14 30	...	97–00	121	740
Blackburn Sydney braced monoplane (British)	Strut floats	21 500		3 Rolls Royce FXII, 1 600	13 00	14 30	100–00	...	...
Rohrbach Romar, cantilever monoplane (German)	Strut floats.	41 900	18 550	3 BMW VI, 1,500	19 60	23 50	121 00	110	...
Savoia-Marchetti S-55 cantilever monoplane (Italian)				2 Isotta-Fraschini Asso, 1 000			79–11	127	1 900
C A M S. 55 H braced biplane (French)		15 873	5 622	2 Hispano-Suiza, 1 200	12 80	12 80	67–00	130	

The electric light and power companies use the airplane

Flying the power lines

By F. V Follett

THERE is a wide field for the use of airplanes in the administration of public utilities. The range of airplane effectiveness in meeting the problems of such concerns is indicated by three prominent users—Arkansas Power & Light Company, Otter Tail Power Company, of Minnesota, and Union Electric Light & Power Company, of Missouri The first has owned a Challenger Robin, the second charters a Robin, Travel Air or Waco, and the third has owned a Wasp-engined Ford.

Transportation of executives, lawyers, auditors, engineers and other employees constitutes one of the chief uses for a public utility plane Arkansas Power & Light Company considers it an effective time saver The Otter Tail Company found the plane very useful and economical and in one year the company's officials flew more than 12,000 miles. Union Electric operated a plane advantageously for transporting officials between the home office and its new Osage River project. Union Electric put the cost of air transportation at $1 per passenger-mile, while Otter Tail Power reports the cost as between 10 and 15 cents per mile for one or two passengers, respectively. While the former cost would outweigh the gain with most companies, the latter is less than the amount for which a suitable plane could be operated today under most conditions.

Observation and survey in construction work is another major use. Not only may much time be saved, but at very moderate cost valuable information may be gained which would be exceedingly difficult and expensive to secure from the ground In selecting a reservoir dam site for instance, it would be a matter of a few flying hours to make a thorough examination, from a physical standpoint, of the most logical sites. Transmission lines from such a power station may be laid out effectively after a reconnaissance of the terrain from the air, a feature well recognized in many engineering departments. Two companies have used their planes successfully for photography; Union Electric has photographed about 300 sq mi of terrain at a cost well below that of commercial work

Transmission line patrol

The third field of operation is that in maintenance and patrol on transmission lines, water sheds and timber lands Transmission line patrol by plane already is a practical, well established, economical method The Arkansas Power & Light Company bought its plane primarily for this work, though later it was used also for transportation of officials and for emergency trips The plane is invaluable at times in locating

Broken insulators, one type of transmission line defects observable from a plane

trouble on lines during bad weather when rain or snow and overflow water conditions hampered transportation on the ground.

The system covers some 1,500 miles of line, broken up into sections of 30 to 50 miles each by sectionalizing switches When a line develops trouble, the particular section wherein the trouble lies is located by switching, and the plane is dispatched immediately to this area, flying low. Each high voltage line in the system is shown separately on a blueprint, arranged on a board having a roller at each end fitted with a crank in such a manner as to permit the print to be wound off continually at a rate corresponding to the speed of the survey plane That part corresponding to the ground over which the plane is flying, is kept always in full view These blueprints give the exact ground conditions along the line, showing geological structures, roads, railroads, and all other possible landmarks Artificial landmarks are set up where there are no natural ones for a space greater than 5 miles By these markers—2x3-ft. boards placed flat on posts and each painted in a different combination of colors—any place on the line may be identified easily

A full time pilot and observer are ready on short notice When a line is in trouble, the load dispatcher immediately calls for the plane and, while the pilot and observer are getting the machine ready, the dispatcher sectionalizes the line and knows the exact area wherein the trouble lies Before taking off, the observer is told by the dispatcher the definite section of the line to patrol. The plane speeds quickly to the closest end of the affected line and thence along the section until the cause and location of the trouble is found. The exact location is determined by counting the number of power-line towers from the faults to the nearest landmark shown on the map

After the point of the trouble is located, the plane is flown to the nearest sub-station. The observer by this time has written the location number on a piece of paper and placed it in a closed paste-board cylinder, such as is used for packing ice-cream. He tosses it out to the substation operator, who telephones the message to headquarters Sometimes a farmer's phone is used, sometimes the observers proceed to the nearest town.

The Otter Tail company found the plane indispensable in repairing the havoc of a severe sleet storm In many places the lines were laid flat, and all communication lines likewise were down From eight to ten trouble crews were rushed into the area, and the planes proved the only practical means of communication between headquarters at Fergus Falls and the crews The assistant superintendent made trips daily to the various crews during the two weeks of fighting this trouble and restoring service He was able to land almost anywhere because that North Dakota ground is comparatively level and there are very few trees Within two or three days of the first break a complete estimate of the damage done was available for headquarters

The company's system includes 3,000 miles of line Patroling is done only during the three winter months Heavy snows block the roads, especially the less important ones which, for the most part, are those the lines follow The company plane has been equipped with skis It proves best to fly at an altitude of 50 to 150 ft above the ground, and 50 to 75 ft to one side of the line where topography warrants it Flying at a higher altitude and using field glasses has been attempted, but a field glass of sufficient power cannot be held steady enough, and continued use of the glass for more than a few minutes tends to make the observer sick

No attempts have been made to cover more than 300 miles in any one day as the strain of continuously looking at a line while moving is somewhat of a hardship on the observer, and in extremely cold weather both pilot and observer suffer more or less from the cold No attempt is made by the plane crew to repair breaks or defects. If a break is spotted, a landing is made as soon as possible and the trouble reported by telephone.

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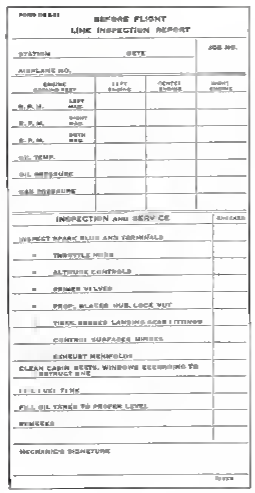


BEFORE FLIGHT
LINE INSPECTION REPORT

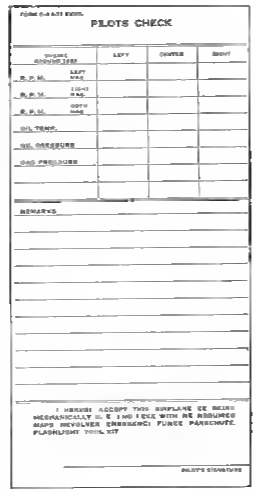
STATION ____ DATE ____ JOB NO. ____

AIRPLANE NO. ____

ENGINE (GIVING TEST)	LEFT ENGINE	CENTER ENGINE	RIGHT ENGINE
R.P.M.	LEFT MAG.		
R.P.M.	RIGHT MAG.		
R.P.M.	BOTH MAGS.		
OIL TEMP.			
OIL PRESSURE			
GAS PRESSURE			

INSPECTION AND SERVICE	INITIALS
INSPECT SPARK PLUGS AND TERMINALS	
" THROTTLE RODS	
" ALTITUDE CONTROLS	
" PRIMER VALVES	
" PROP. BLADES HUB, LOCK NUT	
TIRES, SPRUNG LANDING GEAR FITTINGS	
CONTROL SURFACES, HINGES	
EXHAUST MANIFOLDS	
CLEAN CABIN GLASS, WINDOWS SCRAPING TO INSTRUCT ENG.	
SET CLOCK TIME	
FILL OIL TANKS TO PROPER LEVEL	
REMARKS	

MECHANIC'S SIGNATURE



PILOTS CHECK

ENGINE (GIVING TEST)	LEFT	CENTER	RIGHT
R.P.M.	LEFT MAG.		
R.P.M.	RIGHT MAG.		
R.P.M.	BOTH MAGS.		
OIL TEMP.			
OIL PRESSURE			
GAS PRESSURE			

REMARKS

I HEREBY ACCEPT THIS AIRPLANE AS BEING MECHANICALLY O. K. AND I SEE WITH ME ASSURED MAPS REVOLVER EMERGENCY FLARE PARACHUTE FLASHLIGHT TOOL KIT

PILOT'S SIGNATURE

The final check

THE last, but by no means the least important step in the maintenance cycle for transport airplanes is the final checking by the line crew before turning the machine over to the pilot.

Every operating company has its own ideas as to the method of recording the final inspection and the pilot's acceptance The form shown in the accompanying illustration is that used by Eastern Air Transport, Inc, and is a typical example of a practical style of clearance card Just prior to a flight, the chief mechanic of the line section carries out the operations listed on the face of the card, checking each operation as completed, and after warming up the engines, enters his findings in the appropriate spaces He then signs the card and delivers the machine and the card to the pilot who is to make the run The latter then runs up the engines on his own account, lists the reading of the various instruments, makes his own inspection of the airplane and enters any remarks that he may have to make If he is satisfied that all is well, he signs the back of the card.

Ralph G Lockwood

A maintenance yardstick for the designer

By

Ralph G. Lockwood

THE art of flying has had to develop without benefit of precedents. The business of transportation, however, is of many years standing, and a vast fund of experience is available upon which transport aviation may draw. The type of operation which offers the closest parallel, and which probably can be of the greatest assistance in this regard, is the bus line, for as a transportation unit, the motor bus differs from the airplane only in the way in which it travels. Both are self-driven vehicles, built around the internal combustion engine. Neither needs expensive, privately owned road beds, but both require certain definite terminal facilities, and approximately the same type of equipment for their maintenance

Airplane designers and airline maintenance men are frequently at odds as to what constitutes a good airplane. Mr. Lockwood, chief engineer of Eastern Air Transport, Inc, airplane maintenance man of wide commercial and military experience, presents the first of two articles in which he proposes a plan whereby the designer may check his airplane against certain specific requirements for economic maintenance

The luxurious parlor cars of the road today have little in common with the crude, truck-like buses of ten years ago. More important, however, than the changes in external appearance are the improvements which have been made in design to reduce the cost of maintenance In many cases the overall profits derived from a bus line are represented by the saving which can be effected by the maintenance department, and it is not strange that the requirements of maintenance departments are given first thought in the design of modern motor buses In spite of the fact that the hard-bought experience of the bus operator has been available for the asking, airline managers have been slow to recognize that similar considerations are applicable to their activities to an even greater degree.

The earmarks of many generations of military ancestry are clearly discernible in the modern transport airplane. As is often the case with specialized apparatus or equipment, the military airplane has always required more in the way of upkeep than it could possible produce in the way of revenue and designers are just beginning to realize that changing conditions require a radically different method of approach to the problem Recent experience has shown that airlines are spending from 60 to 75 per cent of their total outlay in the maintenance of their equipment, and it is obvious that the operators are about to find out what the bus people discovered several years ago, that their profits or losses will depend upon how well or how badly their maintenance operations are conducted

The original fault

It is useless, of course, to throw the entire responsibility on the shoulders of the maintenance department, when the original fault lies at the door of the designer. Heretofore the latter has been primarily concerned with the performance of his airplane, its speed, its climb, and how far it will travel on a given amount of gasoline. The airplane structure and the location of the accessories have all been determined from such considerations, and little real thought has been given to the length of time required to keep the machine in condition to fly Fairings, trick cowlings, and other gadgets of a like nature are excellent from the performance point of view, but may easily become the bane of the maintenance man's existence They mean wasted man hours in the shop, and wasted man-hours mean, of course, wasted dollars.

With so much of the total cost being spent through the shops, it becomes apparent that the success or failure of an airline may easily be determined on the designer's drafting board.

About ten years ago the writer, as chief of airplane and engine maintenance at McCook Field, Dayton, Ohio, was struck very forcibly by the fact that the airplanes which were then being delivered to the Army Air Corps were designed with little thought to the problems of maintenance. Records indicated that many machines spent nine hours in the shop for every hour they spent in the air. Difficulties arose not so much from the fact that individual units were difficult to repair, but the arrangement of the various parts was such that it was difficult, if not impossible, to get at certain parts without practically dismantling the airplane For example, on certain types it was impossible to service a water pump without removing radiators, oil coolers, or in some cases, actually lifting the engine from the bearers Cowlings

were, more often than not, bolted firmly in place, and there was a decided lack of inspection doors, or readily removable plates for servicing. Zipper fastenings and transparent inspection windows were practically unknown, and such jobs as servicing or adjusting stabilizer controls or aileron fittings had to be done either from inside the structure or at the expense of removing and replacing sections of the fabric covering.

Measuring for maintenance

In order to remedy such difficulties, a long series of time studies was made on the maintenance operations required for certain types of service airplanes, and tables were prepared to show exactly how many man-hours should be allowed for any particular servicing operation on airplanes of various classes. The intention was to give the designer a yardstick by which he could measure the acceptability of his airplane from a maintenance point of view. When these charts were presented to the manufacturers of aircraft for the Army, the cry immediately went up that it was impossible to meet the requirements set down in the tables, for, in many cases, the time allowed for certain operations was only a fraction of that which was actually required in practice. Several designers expressed a willingness to cooperate, however, and before very long were turning out airplanes which conformed very closely with the specifications set down in the tables. The Verville PW-1 airplane was the first to be produced and delivered to the Army on the basis of such requirements. Although the limits set up in 1921 seemed extremely radical at the time, and could not be met by the airplane designs of the period, yet today, in practically every respect, every type of service machine falls well within them.

If the idea of design for low maintenance proved profitable for the Army Air Corps, there is a hundredfold more reason to adopt a similar procedure for commercial types. In spite of all the progress that has been made in the past ten years, airplanes are still being delivered which can be used profitably only after extensive changes have been made in structure and location of accessories by the airline operator. The designer is naturally a great deal more familiar with methods of stress analysis than with methods of saving dollars and cents in the repair shop, but it is clear that some means must be found whereby the ideas of the design and operating personnel of the aircraft industry can be brought together. As a first step in this direction, it was felt that some sort of guide for designers, similar to the tables established in 1921, but modified to apply to modern commercial types, would be valuable, and the author has prepared a series of charts for this purpose, the first part of which are presented on page 24. A second article will include the remainder of the tabulations.

In making up the new set of tables the plan originally followed was retained. Practically all common servicing operations for both airplane and engine have been listed and the limiting time allowed to perform the operation for machines of certain definite classes has been worked out. The figures appearing in the table represent, first, the number of men required to do the job, and second, the length of time in hours and minutes in which it should be completed. Presenting the data in this form is an indication of both the crew required and the total required labor, for by multiplying the time and the number of men the result becomes man-hours. At a given labor wage rate it is thus possible to translate the figures directly into dollars and cents.

Classifications

Considerable attention was given to the matter of setting up the airplane classification. The intention has been to study the problem, not from the standpoint of any particular airplane design but to establish limits for certain general class groups. At first it was thought necessary to make further subdivisions, taking biplanes and monoplanes separately, and further classifying them as two, three, or four engined machines. It was found, however, that by putting the operation schedule on a unit basis, that is, working out the labor on the basis of one wing, one strut, or one engine, the time as given could readily be applied to any combination of wings and of engines. Although certain operations require less time for one type of machine as against another, compensating factors enter the picture so that the summation of operations for one type of machine gives very close agreement with that for other machines of the same weight and horsepower.

Having established the breakdown of operations and the general airplane classifications, the tables were compiled from a study of a mass of data which had accumulated over a period of over ten years. Time studies and actual maintenance labor records from a number of repair shops were available from which group averages were obtained, and the resulting figures were then modified in the light of the writer's experience to yield limiting values for each operation. It is fully realized that the allowances set down in many cases are impossible with much of the present-day flying equipment. In the second of these articles a study will be made of certain changes in the arrangement of accessories which could be made to permit their attainment. The writer is convinced that by careful consideration throughout the design stages, transport airplanes can be built to meet these requirements in every detail. From an economic standpoint, a repair schedule of this sort must be met if airline operators are ever going to have a reasonable break in the matter of safely reducing their maintenance costs.

It is of interest to note that the table has been checked against actual operations on a number of modern transport airplanes, and although no one machine has yet been developed which meets these requirements in all particulars, there is clear indication that the time limits herein established are entirely reasonable. It is not at all unlikely that the experience with the original tables of 1921 will be repeated during the next ten years, as maintenance figures which seem impossible of attainment today will probably be entirely obsolete by 1940. Progress in this direction is not only desirable but is absolutely necessary if commercial air transport is to survive as a business institution.

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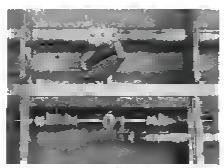
An ingenious aileron control

ALL regular production models and the latest 21A Trainer (described in AVIATION, August, 1931) built by the Consolidated Aircraft Corporation have an ingenious aileron control arrangement which eliminates all exterior fittings and internal cables, pulleys, or torque tubes. It consists essentially of an eccentric yoke-type linkage, one element of which is fastened rigidly to the aileron torque tube and the other pinned to a sliding member supported in bearings attached to the rear wing spar. Movement of the slide is controlled from a straight push-pull tube running into the fuselage parallel to the spar, and connected to the control stick in the cockpit through a suitable linkage. The angularity of the connection between the yoke and the aileron fitting is such that longitudinal movement of the slide is reduced to the desired angular displacement of the aileron.



The Consolidated aileron control

Maintenance standards for design

PART 1: THE AIRPLANE STRUCTURE

	Single-engined airplanes 1 000-3 500 lb. gross weight Open and cabin type			Single-engined airplanes 3 500-7,000 lb. gross weight Open and cabin type			Multi-engined airplanes 7,000-20 000 lb., gross weight Cabin type		
	40-100 hp	100-150 hp	150-250 hp	250-525 hp	525-425 hp	425-650 hp	500-600 hp	900-1,200 hp	1 200-2,000 hp
Landing Gear Group									
Remove and replace landing gear unit	2 0 30	2-0 45	2-1 00	2-1 00	2-1 15	2-1:50	4-1:00	4-1.30	4-1 45
Remove and replace one strut	1 0 05	1 0 05	1-0 02	1 0 10	1 0 10	2-0 10	2-0 10	2-0 15	2-0 15
Remove and replace one brace wire	1-0 05	1-0 05	1-0.07	1 0 02	1 0 07	1-0 10	1 0 10	1-0 10	1-0 15
Remove and replace one wheel	1-0 10	1-0-10	1-0 10	1-0 10	1-0 10	2-0 10	2-0 10	2 0 15	2-0-20
Remove and replace one brake	1 0 15	1 0 15	1 0 15	1-0:15	1-0 15	2-0 10	2 0 10	2-0 20	2 0 15
Remove and replace one wheel streamline	1 0 05	1 0 05	1 0 05	1 0 07	1 0 07	1-0 10	1 0 10	1-0 10	1 0 10
Remove and replace one strut fairing	1 0 05	1 0 05	1-0 05	1-0 07	1 0 07	1-0 10	1-0 10	1-0 10	1-0 15
Remove and replace one shock absorbing strut	1-0 10	1-0 10	1-0 15	2-0 10	2-0 10	2-0 10	2 0 15	2-0 20	2-0-25
Inspection of landing gear	1-0 05	1-0 05	1-0 05	1 0 07	1-0 02	1-0 10	1-0 15	1 0 20	1 0 50
Tail Group									
Remove and replace tail surface complete	2-0 10	2-0 15	2-0 20	2-0 20	2-0-25	3-0:30	4-0:25	4-0-30	4-0 35
Remove and replace one stabilizer	1-0 10	1 0 15	1 0 20	2-0 10	2-0 10	2-0 15	2-0 15	2-0 20	3-0 20
Remove and replace one elevator	1-0 05	1-0 05	1 0 05	1-0 07	1 0 07	1-0 10	1-0 10	2-0 10	2-0 10
Remove and replace one rudder	1-0 05	1 0 05	1 0 05	1-0 02	1-0 10	1-0 10	1-0 12	1-0.15	2-0.10
Remove and replace one fin	1 0 05	1-0 05	1-0 07	1-0:07	1-0 10	1-0 10	1-0 12	1-0 15	2-0 10
Remove and replace one brace wire	1 0 05	1 0 05	1 0 03	1-0 05	1-0 05	1-0 05	1-0 05	1-0 05	1-0.05
Remove and replace one strut	1-0 03	1-0 03	1-0 05	1-0 05	1-0 05	1-0 05	1 0 05	2-0 05	2-0 05
Inspection of tail group fittings and attachment to fuselage	1 0 05	1-0 07	1-0 10	1-0.15	1-0 15	1-0 20	2-0 10	2-0 15	2 0 20
Remove and replace tail skid	1-0 10	1-0 10	1-0 12	1-0:15	2-0 10				
Remove and replace tail skid shock absorber	1 0 05	1-0 05	1-0 02	1 0-10	2-0 07				
Remove and replace tail skid bolt	1 0 05	1-0 05	1 0 05	1-0 05	1-0 05				
Remove and replace tail skid shoe	1-0 03	1-0 03	1-0 05	1-0 05	1-0 05				
Remove and replace tail skid recoil check	1 0 05	1-0 05	1-0 05	1-0 05	1-0 05				
Remove and replace tail skid steering cable	1-0 05	1-0 05	1-0 07	1-0-10	2-0 10				
Remove and replace tail wheel assembly	2 0 05	2-0 05	2-0 07	2-0 10	2-0 12	2-0 15	2-0 15	2-0 17	2-0:20
Remove and replace tail wheel tire	1-0 05	1-0 05	1-0 05	1-0 05	1-0 05	1-0 02	1-0 02	1-0 10	2-0 12
Remove and replace tail wheel shock absorber	1-0 05	1-0 07	1-0 10	1 0 10	1-0 10	1-0 10	1-0 10	1-0 12	1-0.15
Remove and replace tail wheel bearing	1-0 05	1-0 05	1-0 05	1 0 05	1 0 07	1-0 10	1-0 10	1-0 10	1-0.12
Remove and replace tail wheel fittings to fuselage	2-0 05	2-0 05	2-0 02	2 0 10	2-0 10	2-0 12	2 0 12	2-0 15	2-0.20
Inspection of tail skid or wheel fittings to fuselage	1 0 05	1-0 05	1 0 05	1-0 07	1-0 10	1-0.10	1-0 10	1-0 10	1-0:10
Remove and replace stabilizer adjusting mechanism		1 0 05	1-0 07	1-0 10	1-0 10	1-0 15	1-0 15	1-0 15	1-0 15
Remove and replace stabilizer adjusting cable or chain		1-0 07	1-0 10	2-0 07	2-0 10	2-0 15	2-0 15	2-0 20	2-0-25
Remove and replace rudder control cable or tube	1-0 10	1-0 10	1-0 12	1-0 12	1-0 15	2-0 10	2 0 10	2-0 15	2-0 20
Remove and replace elevator control cable or tube	1-0 10	1 0 10	1-0-12	1 0 12	1-0 15	2-0 10	2 0 10	2-0 15	2-0 20
Inspection of rudder and elevator control cable and pulleys	1 0 05	1-0 05	1-0 02	1 0 07	1-0 10	1-0 10	1-0 10	1-0 15	1-0 20
Inspection of stabilizer adjusting mechanism and control		1 0 05	1-0 10	1-0 12	1-0:12	1-0 12	1 0 15	1-0 15	1-0 20
Wing Group									
Remove and replace upper wing continuous	2-0 30	2-0:35	3-0 30	3-0 55	4-0 30	4-0 35	4-0.35	6-0 55	6-0 40
Remove and replace lower wing continuous	2 0 50	2-0 35	3-0 50	3 0 35	4-0 30	4-0 35	4 0 55	6-0 35	6-0 40
Remove and replace upper wing right or left	2-0 15	2 0 20	3-0 20	3-0 20	4-0 20	4-0 20	4-0 20	6-0 20	6-0.25
Remove and replace lower wing right or left	2 0 15	2-0 20	3-0 20	3-0 20	4-0 20	4-0 20	4-0 20	6-0-20	6-0 25
Remove and replace center section	2 0 10	2-0 10	2 0 15	2 0 15	2-0 20	3-0 15	4-0 20	4-0 20	4-0 25
Remove and replace upper center section struts	2-0 05	2-0 05	2-0 02	2-0 10	2-0 15	3-0:15	4-0 15	4-0 15	4-0 20
Remove and replace outer interplane struts	2-0 05	2-0 05	2-0 07	2-0 10	2-0 12	2-0 15	3-0 10	4-0 10	4-0 10
Remove and replace inner interplane struts	2-0 05	2-0 05	2 0 02	2-0 10	2-0 12	2-0 15	3-0 10	4-0 10	4-0 10
Remove and replace flying wires (complete set)	2-0 30	2-0 45	2-1 00	2 1:15	2-1 30	2-1 30	2 1 30	2-1 45	2-2 00
Remove and replace landing wires (complete set)	2-0 15	2-0 20	2-0 30	2-0 35	2-0 45	2-0 45	2-0 45	2-0 50	2-1 00
Remove and replace turnbuckle wires (complete set)	1-0 10	1-0 10	1 0 15	1 0 15	1 0 20	1 0 25	2-0 20	2-0 20	2-0 75
Remove and replace drift wires (complete set)	1-0 05	1-0-05	1-0 05	1-0 07	1 0 07	1 0 10	1-0 15	1 0 20	1-0 20
Remove and replace ailerons	1-0 10	1 0 12	1-0 12	1-0 15	1-0 15	1-0 15	1-0 20	1-0 20	1-0 20
Remove and replace aileron control cables	2-0 05	2-0 10	2-0 10	2-0 12	2-0 15	2-0.15	2-0:15	2-0 20	2-0 20
Inspection of the wings and attachments	1-0 10	1-0 10	1-0 10	1 0 15	1-0 15	1-0 15	1 0 20	1-0 20	1-0 20
Pilot's Compartment or Cockpit									
Remove and replace windshield	1-0 10	1 0 10	1-0 10	1 0 10	1 0 15	1-0 15			
Remove and replace pilot's cabin window (per window)		1-0 10	1-0 10	1-0 10	1-0 10	1-0 10	1 0 10	1-0 10	1 0 10
Remove and replace pilot's seat	1 0 05	1 0 05	1 0 10	1 0 10	1-0 10	1 0 10	1-0 10	1 0 10	1-0 10
Remove and replace window adjustment		1 0 05	1 0 05	1-0 05	1 0 05	1-0 05	1-0 05	1 0 05	1 0 05
Inspection of pilot's compartment	1 0 05	1 0 10	1-0 10	1-0 15	1-0 15	1 0 15	1 0 05	1-0 15	1-0 15
Passenger Compartment									
Remove and replace one cabin chair		1 0 10	1-0 10	1-0 10	1 0 10	1-0 10	1 0 10	1 0 10	1-0 10
Remove and replace one window		1-0 10	1-0 10	1 0 10	1-0 10	1-0 10	1 0 10	1-0 10	1-0 10
Remove and replace one floor	1 0 10	1 0 15	1 0 15	1-0 15	1-0 15	1 0 15	1 0 15	1 0 15	1-0 15
Remove and replace one heater		1 0 10	1 0 10	1-0 15	1-0 15	1 0 15	1-0:20	1 0 20	1-0 25
Remove and replace one dome light		1 0 05	1-0 05	1 0 05	1-0 05	1-0 05	1-0 05	1 0 05	1 0 05
Remove and replace one wall light		1 0 05	1-0 05	1-0 05	1-0 05	1 0 05	1 0 05	1 0 05	1 0 05
Remove and replace one door		1 0 05	1 0 07	1-0 10	1 0 10	1 0 15	1 0 15	1-0 15	1-0 15
Remove and replace one cabin interior covering		1-0 15	1-0 17	1 0:20	1 0 25	1-0 30	1-0 30	1 0 45	1 1 00
Remove and replace one cabin chair upholstery	1 0 05	1 0 05	1 0 02	1-0 10	1-0 10	1 0 10	1 0 10	1 0 10	1-0 10
Inspection of passenger compartment	1 0 05	1-0 05	1 0 10	1 0 10	1-0 10	1-0 15	1 0 15	1-0 15	1 0 15
Alignment									
Airplane complete	2-1 20	2-1 10	2-1 10	2-2 25	2-2 25	2-2 50	2-5 55	2-5 40	2-5 45
Center section	1 0 15	1 0 10	1 0 15	1 0 15	1-0 15	1-0 50	1-0:55	1 0 40	1 0 45
Wings, biplane	1 0 10	1 0 10	1 0 10	1 0 10	1-0 10	1 0 30	1-0 35	1-0 40	1-0 45
Wings, monoplane (used adjustment for balance)									
Ailerons (used adjustment for balance)									
Fuselage	1-1 00	2-0 45	2-0 45	2 1 00	2-1 15	2-1 30	5 1 30	3-1 35	3-1 45

This table shows the number of men required and the maximum time (in hours and minutes) which can be allowed for the performance of all operations listed at the left for the classes of planes indicated by the heads. Multiplying the number of men by the time (changing minutes to fractions of hours) gives the man hours which should be allowed for a given job.

EDITORIALS

AVIATION

EDWARD P WARNER *Editor*

An aviation platform

THE first condition of progress is that we shall know where we are going If the aviation industry is to get out of the depression with a minimum of wasted time and effort, there must be some very careful preliminary consideration of the general policies to be pursued A series of inspirations will not do the trick We must adopt some chart by which we can maintain a consistent course

Business platforms are designed to provide such a chart Great store of them have been prepared in the last two years A few months ago the McGraw-Hill Publishing Company developed a program for American business, and it was distributed as a supplement with the April number of AVIATION The principles that it contained were admirable, the fruit of deliberation and recommendation by experts in many fields, but since it undertook to cover the whole of commerce and industry it was necessarily very broad and general The time is ripe for becoming more specific and detailed, and for giving general principles a definite application to the particular problems of the aeronautical world There is much that can be done by individual manufacturers and operators There is much that requires collective action of a considerable group, operating through the Aeronautical Chamber of Commerce or otherwise The opening of a new year offers an excellent occasion for listing the items of an aeronautical industry program Herewith, the beginning of such a list

Fundamentals

1. Be properly sceptical towards miracles. Airplanes have now been flown for 28 years and nobody has discovered any magic in all that time Periodically there comes forward some formula, or slogan or recipe, which is to be the over-night salvation of the business The great glider excitement of 1930 was a spectacular case in point Most such panaceas result in the waste of a great amount of energy and money which might far better have been devoted to normal development on normal lines Certainly there is no occasion to condemn novelty, but it is time for us to stop acclaiming novelties with such fervor that we overlook the well-tried paths of the past It is poor economy to neglect the business that we know we can get, in going after what someone has told us that he thinks we ought to be able to get

2. Stop living in the future. The whole aviation business has been cursed for many years by its visions of technical progress to come Aeronautical enthusiasts have spoken before a thousand luncheon-clubs, and told them of what was going to happen,—of airplanes cruising at 200 miles an hour,—of jet propulsion through the stratosphere,—of planes more economical and simpler to operate than an automobile Not unnaturally, the average listener remarks to himself that if the present planes are so inferior to those that are about to be developed, he will wait a little longer before purchasing a machine, or even riding a transport line There is plenty for us to boast of in our present products So far as our relations with the general public are concerned, we should make the most of what we can offer now, and stop talking about what we expect to offer one, five, or twenty years hence. There ought to be an absolute embargo on prophecies of technical progress in all addresses to non-aeronautical audiences

3. Abandon delusions of grandeur. In 1929 it was widely anticipated that the aircraft industry would quickly grow to rivalry with the manufacture of automobiles, or steel, or electrical machinery For the present, at least, such hopes have proved unfounded, and we have a relatively small industry Small industries can be highly profitable, but only if they act in a fashion appropriate to their size If we do our thinking and planning in terms of from $40,000,000 to $100,000,000 a year we can get along nicely. If we insist on thinking in terms of billions, and planning accordingly, financial catastrophe will be inevitable.

4. Revise capital structure to fit the facts. As a natural consequence of unduly optimistic estimates of a few years ago on the amount of business to be done, some companies are burdened with a capital structure out of all proportion to the present magnitude of their activities They have seen their securities decline in many cases to one-tenth the issue price or less, and some of them have little or no prospect, for many years of finding enough business to justify the figures at which the stock was first put out Those facts ought to be recognized without further delay, and a general revision of the financial structure undertaken in any such case So long as the company continues its original identity, with its originally-issued securities still valid, investors will compare the present price of their stock with what they paid for it and will find ground for dissatisfaction in everything that is done This is the time, in the interest alike of the managements and of the present holders of aeronautical securities to sweep the slate clean and take a fresh start, so that we may break away from the unhappy habit of rating everything in terms of 1929 Henceforth, 1931 should be our yardstick for determining the progress of the industry Not only capitalization, but other balance sheet items, and particularly inventory, have to be ruthlessly brought down to a 1931 basis

5 Cut out the hippodroming The airplane outlived its usefulness as an attraction for county fairs by 1914 It no longer finds proper employment as an instrument for giving thrills The industry ought to oppose, without reserve, all public stunting exhibitions, whatever their occasion It ought to oppose every display of aircraft that borders on the spectacular That includes not only outside-looping demonstrations, but a very large number of cross-country and trans-oceanic flights

6 Take the whoopee out of aviation. We have had a long and hard fight to gain recognition as a respectable business run by respectable business men, and to overcome the widespread belief that flying was a dissipation indulged in only by eccentrics and dare-devils with no thought of the morrow Anyone who has accompanied an air tour has received regrettable evidence that, even in 1931, there are a great many chamber of commerce officials who think that the fundamental necessity in entertaining an aeronautical group is to give them enough liquor to drown themselves in It is up to those who have the future at heart to combat that sort of "entertainment" and the idea that lies behind it in every possible fashion,—first by opposing it in their own communities second by absolutely refusing personal participation in any such manifestations, and third by impressing it on the members of their organizations that they must do likewise Anything that associates the idea of aviation in the public mind with rowdy and irresponsible behavior is a positive and a serious detriment to the progress of the industry

7. Develop an industry policy on legislation. The aeronautical industry, as a whole and in its several divisions, is going to be the subject of an immense amount of legislative activity at Washington and in the state capitols in the next few years Taking us as a whole, we have been insufficiently watchful of our own political and legislative interests in the past The recent expansion of the legal work of the Aeronautical Chamber of Commerce is an excellent sign, but beyond that there is need for a very strong committee of executives, representing the industry as a whole, which will be prepared to speak the mind of the industry on all legislative questions We have already urged in a previous editorial that a group of leaders of the industry should go before the Bureau of the Budget and state their case there. It is equally important that men whose names bear weight and command general respect should be prepared to go before committees considering important legislation, and to present the point of view which has been determined to be representative of the best thought of the whole industry. This is a task that cannot be delegated to permanent legislative representatives, nor to associate counsel, nor to anybody else

8. Prepare to fight the question of air space ownership. The Worcester airport and the Cleveland-Curtiss airport cases, decided in 1930, present the most serious threat to the whole future of aircraft industry that it has ever had to face If those decisions, particularly the Cleveland one, be generally confirmed, or if they be taken as a point of departure and still further broadened, a very large proportion of our present airports and present aerial operations can be found illegal Every case involving the ownership of air space or questions of aerial trespass, however obscure the jurisdiction in which it may be brought, is of concern to the whole industry The defense ought to have the backing of the whole industry There can hardly be any one of the Aeronautical Chamber's activities that is of more importance than a constant vigilance against any weakening of the legal position of aircraft

9. United front against state regulation. The control of aircraft by state authority under Department of Commerce regulations, and the enactment of legislation requiring federal licenses on all planes, may be very wise and helpful measures In fact, they usually are The organization of an independent system of state regulation, however, with the state formulating its own ideas on airworthiness and on pilot fitness, setting up standards entirely distinct from those of the federal government and then collecting the cost of all this work in license fees from the owners and operators of aircraft is a menace which cannot be over-rated A few states have already made a dangerous amount of progress along those lines If the industry is to have a coherent legislative policy and to find means for reaching a decision and making its voice heard upon the wisdom of pending legislation, this is among the first subjects to demand consideration And consideration will lead to alarm, and to determination to resist as vigorously as possible any further development of duplicated state and federal activities

10 Agree on a policy on gas tax Some states are collecting a tax on aviation fuel and putting it into the general funds Some are collecting it for the specific purpose of aiding in airport construction and developing air navigation facilities Some are exempting all aviation gasoline, some exempting only that which can be demonstrated to be employed in interstate traffic All of those courses, except the first, find defenders within the industry It is time for the industry to take counsel in its own ranks, decide what can reasonably be expected from the states in the way of help for aviation and under what conditions it can be expected, and then prepare to bring its conclusions to the attention of the legislative bodies of the 48 states. We on AVIATION

are inclined to favor the collection of a moderate gas tax, with exemption for fuel used in airline operation and with the proceeds reserved for aeronautical purposes. The exact nature of the conclusions reached, however, is of less importance than that there should be some conclusion. The industry should give some very clear sign of knowing its own mind in the matter.

These are things, to be done or to be avoided, that affect the aeronautical community as a whole. Beyond the arraying of such general fundamentals, it is possible to become still more specific. For each division of the industry there are particular policies that ought to form a part of the budget of New Year's resolutions.

Transport

1. Strive for agreement on optimum operating conditions. If a group of merchant ship operators meet together to discuss the type of service that should be provided on a given route they will find but little difficulty in reaching essential accord on the type of craft and the type of service that will best fit the case. Railroad men can arrive at a consensus even more easily. But air transport experts, broadly speaking, are in agreement on nothing. Between the single engined and the multi engined planes, between ultra-rapid machines and those of moderate speed between giant craft at long intervals and those of modest size on a high-frequency schedule, between cabins large enough to permit free circulation of the passengers and those cribbed and confined to the minimum in the interest of reduced air resistance, over the eternally vexed question of the relative merits of low fares and of comfort and luxury as traffic inducers: on these and many other problems, it is possible to start an argument at any moment.

Obviously, in most cases one view is right and the others are wrong. Obviously, none of these matters are to be settled by hunches. Most of them require close economic analysis. It may be undertaken cooperatively, or it may be done by individual operators, but somehow it must be done. Air transport decisions have often had too much prejudice and too little research as a background. There has been a great improvement in that respect in the last few months but there is a call for a much more general, and a much more intensive, use of the analytic method.

2. Bigger and better traffic surveys. The travelers by air as yet constitute only a small fraction of the traveling public of the United States. We have the right to expect that we shall ultimately get all of them on occasion, and a great proportion of them for most of their travel mileage, but to attain that happy state of affairs we must find out what it is that is causing so many of the potential patrons still to hold aloof.

No doubt in many cases it is merely failure to form the habit of air travel, but even the formation of a habit can be accelerated or retarded by the quality of the promotion work done. In other instances there are more positive factors that operate against the use of the airlines. They demand careful investigation. We need to find out what features of our service appeal most to those who are now using it, and what features seem weakest. We need to determine what flaws of omission or commission are interfering with the still more rapid growth of transport patronage.

This is definitely a field for cooperative effort. All the airlines are in it together, and they all stand to profit together. One or two of them have already made excellent traffic surveys as independent undertakings, but we should go much farther. We should cover a broader group of prospects, and cover them more intensively. Proper surveys will help to solve many of the questions that arise under the preceding plank of the transport platform.

3. Agree on a policy towards the air mail. Although there are a number of transport operators who are going along very steadily without mail contracts, the Post Office Department continues the mainstay of the transport business. Sixty-five per cent of the total of American transport mileage is being flown with mail at the present time, and 75 per cent of the total income of the transport companies comes to them through the Post Office Department. Manifestly postal policy, and the policy of Congress in respect of the air mail, are of the greatest importance for the healthy development of the business. Uncertainty about the economic future of air transport, and about the necessity or otherwise of an indefinite continuance of government support, is a confusing factor in the Congressional mind. Some of the transport operators incline to the belief that it is proper that a permanent federal contribution be made to keep up the air mail as a necessary public utility. Others anticipate that the business will be entirely self sufficient within a few years, and that the Post Office Department's income from air mail will exceed the total outlay. We on AVIATION are emphatically in sympathy with the second view. It may take three years to reach independence, as we have prophesied from time to time and as an extension of the curve of experience since 1928 would indicate, or it may take five or six or longer. In any case, we believe that it is of fundamental importance that the air mail operators should get together, prepare a reasonably conservative forecast of what can be expected in the way of reduction of costs and of progress toward independence of any sort of subvention or financial assistance, and stand ready to lay their collective views before the appropriate governmental officials and Congressional committees. We believe that Congressmen will be much more inclined towards generous treatment of air transport during its present critical period if they feel that the transport operators and the Post Office department know very definitely where they are going and that they have taken Congress into their confidence. There is everything to be gained from a careful collective examination of the prospects in this matter, followed by a display of complete frankness.

(*To be continued in February*)

NEWS OF THE MONTH

More record flights

A THREE-FOLD triumph, the first west-to-east flight across the South Atlantic, the first trans-Atlantic flight of a light airplane, and the first solo ocean crossing since Lindbergh's was scored by Squadron Leader Bert Hinkler in a 22-hour flight from Natal, Brazil, to Bathurst, in Gambia, on the west coast of Africa, on Nov. 26-27. His Toronto-built de Havilland Puss Moth monoplane with its 120-hp. Gipsy engine, differing only in its extra fuel tanks and navigational equipment from the standard models in general private use, made the 1,950 mile ocean trip, which included a six-hour battle with high winds and electrical storms, on 164 gal. of gasoline. When Hinkler, who in 1928 set the record for the England-Australia flight at fifteen and a half days, reached England again he had flown 10,500 miles from New York, mostly in over-water flights of 1,000 miles and longer. He carried no radio equipment.

A few days later James Wedell and Capt. Frank Hawks took off, one from Agua Caliente, the other from Vancouver, in a concerted attempt to lower the record time for a border-to-border flight. Captain Hawks was forced down near Granada, Cal., made ill by gas fumes from his engine, but Wedell landed at Vancouver 6 hours, 40 min. after his take-off in Mexico. Wedell flew the same racer, of his own design, powered with a Wasp Junior, in which he took second place in the Thompson Trophy race at Cleveland. His time, including an eleven-minute stop for fuel at Reno, was 1 hour, 8 min. better than the record set by James Goodwin Hall last June.

Another city-to-city record fell to Lou Reichers, who flew a Lockheed Altair with retractable landing gear and a Cyclone engine from Newark to Havana, with one passenger, in 6 hours, 41 min. flying time, 22 minutes better than the record made in July by Captain Hawks. The distance was 1,400 miles. The next day Reichers attempted to set a new record for the return trip, but fell five minutes short of equalling the time made by Captain Hawks, who had made the round trip in a single day.

Practically the only aviation speed record standing unbeaten since 1924, the world landplane speed record set by Warrant Officer Bonnett of France at 278.4 m.p.h., withstood the recent attempts of Lowell R. Bayles to improve upon it. His speed trials made at Detroit on Dec. 1 were at first thought to have broken the old record at 284.7 m.p.h. but a recheck showed that the average time made in four flights over the 1.8 mile course was only 281.9, lacking a mile and a half of the margin necessary to secure the recognition of the Federation Aeronautique Internationale for a new record. The next attempt was fatal. Flying at a low altitude his plane rolled twice and crashed to the ground at about 300 m.p.h. Bayles' Gee Bee monoplane was powered with a Wasp engine supercharged to 745 hp., replacing the Wasp Jr. with which it was flown at the Cleveland races last fall, when it won the Thompson Trophy at 236 m.p.h. Dimensions of 22½ and 15 ft., a wing area of only 75 sq. ft. to support its increased flying weight of 2,280 lb. made the plane exceedingly dangerous to fly.

To regain for the United States the world's air speed record, now held by Flight Lieut. G. H. Stainforth, R.A.F., at 407 m.p.h., is the aim of the Aviation Speed Foundation, incorporated under the laws of Ohio by a group of Mystic Shriners. A fund of $16,000,000 is to be raised over a five-year period—or so the story goes—largely by contributions from the 8,000,000 members of the Shrine, though participation is open to groups and individuals all over the United States.

Prepare for distance attempt

Preliminary to an attempt on the world's non-stop straight line distance record, held by the U. S. since the New York-Istanbul flight of Boardman and Polando, a new Napier-powered Fairey long range monoplane recently flew 2,857 miles from Cranwell, England, to Abu Sueir, Egypt. The controls were left in charge of a "robot pilot" during a large part of the flight. The plane, which carries 1,440 gal. of gasoline, is tentatively scheduled for a 6,000-mile flight non-stop from Cranwell to Cape Town.

A very different sort of record is credited to Dr. John Brock of Kansas City, who recently made his 730th consecutive flight, having missed not a single day in the air in the last two years.

A distance flight is also being planned for Dutch military pilots. A plane having three engines of 450 hp. each, and reported capable of 200 m.p.h., has been designed by the Pander company of Rotterdam to make in 45 hours the flight between Amsterdam and Batavia, regularly covered by the Royal Dutch Airlines in ten days.

Calendar

Jan. 4-7	New York-Miami Cruise Amateur Air Pilots Association.
Jan. 7-9	Fourth Annual Miami All American Air Races, Miami, Fla.
April 2-10	National Aircraft Show Detroit, Mich.
June 25	13th Annual R. A. F. Display, Hendon

R.100 passes out

Britain's last dirigible, the R.100, is being sold for scrap. Engines, fabric and gas bags are being retained by the Air Ministry, which spent about $10,000,000 for the two airship and mooring masts in Canada, Egypt, and India. Launched in December, 1929, the R.100 made one voyage to Canada and back and last January showed a speed of 81½ m.p.h., beating the record of the Graf Zeppelin, but otherwise had made few flights of public interest.

The airship stations at Howden, Yorkshire, where the R.100 was built, and at Cardington, Bedfordshire, late home of the R.101, are being considered by Dr. Eckener as possible sites for the construction of airships for trans-Atlantic passenger service.

Adverse criticism of the excess weight and slower speed of the navy airship Akron was answered by Rear Admiral William A. Moffett, Chief of the Navy Bureau of Aeronautics. The Board of Inspection and Survey had found the airship entirely airworthy, and satisfactorily in accord with contract and specifications. The ship had been violently assailed by Congressman McClintic of Oklahoma, anti-Navy member of the Navy Affairs Committee of the House. After several trips up and down the eastern seaboard the Akron is standing by for installation of hangar handling equipment, launching and arresting gear for the airplanes which are to be accommodated within its hull. Its inauguration as the country's first fighting airship, neither the Los Angeles nor the Shenandoah having been similarly equipped, is expected to be marked by a trip to the Pacific Coast for fleet maneuvers, and possibly to Hawaii where the mooring mast a few miles north of Honolulu is being overhauled and made ready.

Work on the Navy's dirigible base at Sunnyvale, Cal., is going on at top speed. A temporary mooring mast

is under construction, scheduled to be ready for the Akron's use by the middle of February, and piles are already being sunk and work begun on the foundations of the hangar itself

The annual report of the Chief of Naval Aeronautics to the Secretary of the Navy emphasized the need for liberal appropriations, over a period of at least three years, to provide for research in engine development, both for high speed flight and for use in rigid airships. The German-made Maybach engine is the only one at present considered suitable for use in large airships. The report includes the accident record of the service for the fiscal year, during which naval aviators flew 10,207 hours for each fatality, a record not quite equal to that of 1930 and slightly below the Army's safety record for 1931.

Schiff trophy goes to reserve

Three thousand four hundred and forty-one hours without serious accident to personnel or equipment is the achievement of the naval reserve aviation unit at Floyd Bennett Field in Brooklyn, N. Y. In recognition of that record it received the Schiff Memorial Trophy for the year. Donated in memory of Lieut. Herbert Schiff, the trophy until 1929 was awarded annually to the pilot having flown the greatest number of hours without accident, but revised rules since that date give it to the squadron or unit having the best record of freedom from accident for the fiscal year. Squadron Seven at the Naval Air Station in San Diego, and Fighting Plane Squadron Three, attached to the U. S. S. Langley were previous recipients, with records of 8,159 and 4,958 hours, respectively.

En route to winter maneuvers in Guantanamo Bay, 75 or 100 naval planes are scheduled to take part in the Miami air meet in January. The airplane carrier Wright, with 24 planes, will attend as will 45 planes from the aerial scouting fleet. Machines from the air station at Pensacola will make up the rest of the contingent.

Stinson cuts price

The Stinson Aircraft Corporation, coincident with its report of a gross volume of sales greater than ever before, announce price reductions which make the ten-passenger tri-motor $19,500, the only transport plane of similar capacity available for under twenty thousand dollars. The old price was $25,900. The Stinson company made this reduction as an encouragement to air line operations, with the conviction of the necessity for lower first costs on planes to release money for traffic work and to increase the payload factor. At the same time, without waiting for the show as is customary, the price on the standard Junior is cut from $4,995 to $4,595.

Fifteen Hart two-seater observation planes have been ordered by the Belgian Army from the Hawker Engineering Company in England at a cost of about $462,000. The price included the Rolls Royce Kestrel engines, supercharged to develop 486 hp at 10,000 ft., complete armament and equipment. This is the third order for fifteen planes which the Belgian Army has placed in England in the past year, while 30 more Firefly single seaters were manufactured in Belgium under license.

The growing use of barter to replace currency transactions has made itself felt in military aviation. Uruguay would like to buy planes for use in its army flying school, provided they may be paid for in hides, wool, meat and other Uruguayan products. The Minister of War has sent to the legations of various countries describing his needs and asking for bids.

The Heath Aircraft Corporation, long familiar to light plane enthusiasts, is the beneficiary of a new and unique action by the Department of Commerce. An approved type certificate has been granted on its Model LN to cover both factory-made and home-assembled planes. Thus, persons who prefer to make their own planes can henceforth license them. Otherwise, home builders would have been unable to operate under the laws now in force in most states. All parts being factory-made, the plane needs only assembly and covering by the amateur.

The first of the air training bases which Chinese-American organizations have planned to set up in this country is to be at Charlotte, N. C. Thirty training planes are to be ordered, barracks built and eight or nine instructors added to the regular air school staff to train the first class of 100 Chinese-American youths from all parts of the country.

To eliminate overlapping territories and duplication of sales effort, the Curtiss-Wright Flying Service is making extensive changes in sales territories throughout the U. S. Four Long Island airports which have hitherto been independent demonstration centers are being combined into one sales district, which includes, in addition, all New York state, eastern Pennsylvania, northern New Jersey, and part of Connecticut.

A CABIN-SIZED GIRO

The Kellett (100-hp. Continental engine) with removable top

Financial reports

Financial reports of the Curtiss-Wright Corporation for the third quarter and first nine months of the year show net losses not attributable to two manufacturing subsidiaries for which separate reports are made. Net losses of the Curtiss-Wright Corporation for the third quarter of 1931 were $676,234 after depreciation, interest and other charges, while for the nine months ended Sept. 30 losses were $2,139,388 after $1,973,811 provision for depreciation and amortization. For similar periods of the preceding year the net losses were $1,807,594 and $7,159,255, respectively.

Both Curtiss Aeroplane & Motor Company and Wright Aeronautical Corporation show a net profit after charges for the third quarter of the current year. Curtiss Aeroplane & Motor netted $102,834 as against $107,706 in the third quarter last year, and $136,379 in the first nine months of this year. The first nine months of 1930 showed a loss of $91,804. The net profit of the Wright Aeronautical Corporation after charges for the third quarter of the current year was $293,736 as against a net loss of $657,944 in the same period last year, while a net loss of $23,548 for the nine months ending Sept. 30, 1931, is to be compared with a $1,932,189 loss for the first three quarters of 1930.

In its report for the fiscal year ended November 30 the Douglas Aircraft Company shows a net profit of $689,650, $2.02 per share on stock outstanding, exactly the same as the 1930 figure. Sales for 1931 were about $3,824,000, only 6 per cent below the total for 1930. Foreign sales for the fiscal year established a new record, almost $500,000. Five new types of plane were developed during the year, including the Dolphin amphibion and several military models.

The Kinner Airplane and Motor Corporation, Ltd., reports for the first nine months of 1931 an operating loss, after reserves and absorption of development costs, of $92,817. Change in the method of handling these costs prevents any comparison with last year. The Kinner company has just announced a new 150-hp. engine to complete its line of five-cylinder radial engines, now available in 100, 125, 150, and 200-hp. models.

A permanent receiver has been appointed for the Paramount Aircraft Corporation. All creditors are notified to file their claims within 90 days.

Legal decisions

The material immediately following, together with references to legal and legislative matters elsewhere in the news pages, is based largely upon the Aviation Law Service prepared by the Commerce Clearing House, Inc. AVIATION is licensed to make use of the service, and is able to give its readers the benefits of the work of an organization specially trained and equipped to insure the complete collection of pertinent material on current legal developments.

Precedent is rapidly being accumulated for the decision of cases involving aeronautics. The clause "engaging in aviation" has once again been vainly claimed as relieving an insurance writer of liability for the death of the insured in a case of Flanders v. Benefit Associa-

FOKKER PURSUIT

The D.XVI fitted with Armstrong Siddely Jaguar, claimed to be capable of maximum speed of 191 m.p.h. at 10,000 ft.

tion of Railway Employees. A railroad employee, while on a visit to the Lambert-St. Louis airport had been given a ride in an airplane which had crashed on landing, causing his death. Tried by the court without jury, the judgment was rendered in favor of the Benefit Association, which had denied its liability, but on submission to the St. Louis Court of Appeals judgment was reversed and recovery on the insurance policy allowed the father of the insured. The court ruled that "engaged in aviation" implies some continuity and means that one must take part in some aviation operations aside from merely being in a plane as passenger.

Another question under frequent discussion is the liability of the airline operator in case of the death of a passenger in a crash of a transport plane. In action brought against the Transcontinental Air Transport by the widow of Dnif C. Law in the U. S. District Court in the Eastern District of Pennsylvania previously reported settled out of court (August, 1930) the defendant was finally conceded to be a common carrier, leaving the burden of the proof to establish the negligence of the airplane pilot. In landing downwind instead of upwind as usually prescribed by the Department of Commerce, the pilot had overshot the Indianapolis landing field during a snowstorm and crashed into a stump, thereby killing Mr. Law. The jury returned a verdict in favor of the plaintiff, his widow, to the amount of $5,000.

When Lloyd O'Donnell, well-known Long Beach operator, appealed the decision of a lower court awarding $2,000 damages to James W. Smith, who was injured in an accident to the plane in which he was a short-hop passenger, the verdict was sustained. Thus by decision of three judges of the California District Court of Appeal even miscellaneous commercial passenger flying is a common carrier activity.

The case of Eastern Air Transport, Inc. v. South Carolina Tax Commission, under the decision holding constitutional a state statute imposing a tax on gasoline intended to be used by aircraft flying in interstate commerce, as reported in the November issue of AVIATION, has been appealed to the United States Supreme Court.

The first violator of provision of the new Mexican aviation law prohibiting low flying over inhabited or occupied places was fined about $40 for flying low over the crowded Mexico City bullfighting arena. The government has announced that it will deal even more sternly with future violators.

A law recently enacted by the Alabama legislature creates a State Aviation Commission composed of one member, a commissioner appointed by the Governor to serve without compensation. No aircraft or pilot may operate in the state without registering with the Commission and obtaining a permit, for which a Department of Commerce license is a prerequisite.

Legislation in prospect

Among the bills and resolutions dealing with aviation which may be submitted to Congress during the current session is one by Senator Bratton of New Mexico concerning the regulation of commercial interstate air traffic. The Bratton bill is an effort to transfer airline jurisdiction from the Department of Commerce to the Interstate Commerce Commission, partly as a result of the refusals of the Department to release intimate details of several transport accidents. Not popular last session, the bill is not likely to make much progress this winter.

Legislation to extend the authority of the Department of Commerce, to include supervision of airports used in interstate airline traffic and general zoning powers over structures in the neighborhood of airports which would be a menace to navigation, may be offered by Senator Bingham if it becomes necessary. The prospective erection near the Washington airport of a memorial consisting of two high shafts may force the issue.

Most likely of enactment are bills relating to the air mail situation. Amendment to the present air mail act, to restrict the authority of the postmaster general to suspend competitive bidding in awarding contracts is likely to be sponsored by Representative Mead of New York, new chairman of the Post Office Committee. He believes that the distribution of postal aid in the development of a sound commercial airline system should be general, rather than concentrated on a few companies. The Appropriations Committee of the House intends to continue its investigation of air mail contracts, under the chairmanship of Representative Byrns of Tennessee, who succeeds Representative Wood. Representative Byrns has in the

past been known as very favorably inclined toward commercial aviation

Legislation which Representative Woodruff of Michigan plans to introduce in Congress would extend the Dyer Act to cover airplanes and water carriers. The Dyer Act makes it a criminal offense to transport a stolen motor vehicle in interstate commerce, but according to a decision by the Supreme Court (AVIATION, April, 1930), an airplane is not a motor vehicle within the provisions of this act. There is no federal statute to cover the theft of airplanes or water vessels, and at present a person stealing an airplane and taking it to another state can be apprehended only by extradition process.

A branch office of the Medical Section of the Aeronautics Branch to serve the Middle Western States has been opened in Kansas City under the direction of Dr. Eldridge Adams, lately assistant medical director in the Washington office. The new office will enable the medical examiners in the area, of whom there are about 800, to keep in touch with the Department's policies with regard to medical requirements and examinations.

Technical developments

Annual reports from the National Advisory Committee for Aeronautics, and from the British Aeronautical Research Committee outline a number of important research activities. During the year, the N.A.C.A. completed important additions to its research equipment, including the full scale wind tunnel and seaplane basin. Emphasis was placed on the need of developing aircraft suitable in safety characteristics for non professional use, in order to develop the commercial aircraft industry. Tests were made with the autogiro and with machines embodying slots and wing flaps.

British research was centered around problems of aerodynamic interference, diesel engines, load factors, and the sleeve valve. A large size seaplane channel is under development. Work on interference due to engine nacelles covered much the same ground as the studies made by the N.A.C.A. during the past two years, and led to much the same conclusions.

The de Havilland company in England is bringing out a new low wing monoplane called the Swallow Moth, powered with an 80 hp Gipsy, and said to have novel aerodynamic features. Also under development is a biplane resembling the conventional Moth, but fitted with a highly staggered wing cellule.

Technical developments in the Air Corps include a new five-lens camera, covering a very wide angle with its one vertical and four oblique lenses. Its first service test was in photographing 3,600 sq mi in northwestern Maine in two flying days. Operations were at 20,000 ft with oxygen, at which altitude the camera covered an area 20x75 miles. Developed by the Materiel Division at Wright Field, it is used in connection with a rectifier to correct the foreshortening of the oblique pictures. The principle is essentially similar to that of Major Bagley's tri-lens camera, introduced about 1918.

The Army also has been making progress with tests of hollow-steel propellor blades. The welded Dicks blade, displayed at the Detroit show last April, has reached service test, and the pressed tubular type is in the experimental stage. Research on controllable pitch propellers has progressed slowly. The Army also reports that service tests favor use of oxygen fed to the face through a mask rather than of oxygen fed into the mouth through a tube.

The General Electric Company has introduced a new globular 3,000 watt, 32 volt lamp (7 in in diameter), for airport floodlights. The round bulb with the filament at the center eliminates the formation of a line of light due to internal reflections, permitting better control of the beam and, in some cases, elimination of light-absorbing louvres.

The British War Office announces the development of a searchlight throwing a criss cross pattern on the sky, permitting more efficient plotting of the course of raiding enemy planes. The beam consists of 300 shafts of light, forming a grid of sixteen squares. A light of 3,000,000,000 beam candlepower is used, exceptionally high even for a search light.

HOME OF ITALIAN AIR MINISTRY

The new building recently completed as headquarters of Italian aeronautics. Around the central staircase are statues of the country's famous airmen. The figure surmounting the building resembles the Savoia-Marchetti S55, the type used in the trans-Atlantic squadron flight.

Farman stratosphere plane

German and French rivalry in exploring the stratosphere in heavier-than-air planes looms up with the almost simultaneous completion of a Junkers and a Farman, each specially built for this work. The Farman is a high wing monoplane similar to the Farman 190, a model corresponding somewhat to the Stinson or Bellanca type. It has an airtight cabin fitted with oxygen equipment, a span of 61 ft, an aspect ratio of 4.8. The engine is an inverted Farman developing 430 hp at ground level fitted with three centrifugal superchargers which may be operated independently or together. They will go into action successively at 20,000, 30,000 and 48,000 ft., the engine power thus remaining substantially constant to above that level. A four-bladed controllable pitch airscrew with a diameter of 15.1 ft. has been fitted. Speeds anticipated are 129 m.p.h. at ground level, 179 m.p.h. at 16,404 ft., 245 m.p.h. at 32,808 ft., and 317 m.p.h. at 62,700 ft. A photograph of the Junkers machine was published in the news pages of the December issue of AVIATION.

In the meantime the Short Brothers, producers of aircraft in England since 1909, are planning to build the largest balloon ever constructed and to penetrate the stratosphere beyond Professor Piccard's record altitude. A hermetically sealed metal globe will accommodate three passengers.

Reinhold Tiling recently demonstrated a 60-in. rocket "space" plane in Germany. Actuated by liquid explosive, the model rose to about 30,000 ft. On reaching its highest altitude the wings unfolded and the device glided to the ground. Further experiments will be made before attempting a man-carrying model.

Daily high altitude (17,000 ft.) weather observations are now being carried out by the Massachusetts Institute of Technology with a Warner-powered Cessna. Observations are recorded with a meteorograph, which registers temperature, barometric pressure and relative humidity, and the results are interpreted by Carl G. Rossby, M.I.T. professor of meteorology, and his staff.

Much interest has been aroused by experimental flights with a tail-first plane built by the Granville Brothers Aircraft Company at Springfield, Mass. This is the first recent American study of this type, old in principle but made prominent in recent years by experiments in Germany. The Focke-Wulf company is now flying its latest tail-first model around Europe on a demonstration tour.

Two new models of the autogiro have demonstrated in England. Both have the new three-bladed rotor, which is freed of inter-blade wires by additional stiffening at the hub, and which may be folded to permit easier parking. One model, in which a cabin has been achieved and the rotor support enclosed in a stream-line casing, is powered with an inverted Gipsy III engine of 120 hp. and has a high speed of about 118 m.p.h. Improved performance has been obtained by the fairing of the superstructure to provide the cabin.

Under the leadership of the Glider Section of the Rhode Island Aviation League, a New England Glider Association was organized at Providence on Dec. 12. Arthur L. Lawrence of Providence was elected president. The association plans a school for gliding instructors, a semi-permanent soaring camp, and an annual gliding and soaring contest.

In the attempt to get a world endurance record for gliders, Lt. William J. Scott, Wheeler Field, Honolulu, soared for 6 hours, 36 min. and 15 sec. over the Nuuanu Pali, famous Hawaiian cliff; the wind failed, and brought him down short of his goal.

Show, meetings, tours

About half of the available floor space in the hangar exposition building at the Detroit City Airport, again to be the scene of the National Aircraft Show next April, already has been spoken for. Among aircraft manufacturers who have so far made application are Pitcairn, Waco, Great Lakes, Stinson, Ford, Nicholas Beazley, Curtiss-Wright and Bellanca. William B. Mayo, chief engineer of the Ford Motor Company, has been named chairman of the show board of control, and George S. Wheat, vice president of United Aircraft & Transport Corporation, vice-chairman. Ray Cooper, as usual, will be manager.

The first annual meeting of the National Association of State Aviation Officials was held at St. Louis Dec. 3-5. As a result of the election for permanent officers for the year Capt. Frank M. McKee of Ohio was elected president, Reed Landis of Illinois executive vice-president, A. H. Stackpole of Pennsylvania secretary and treasurer. The association seeks uniformity in state administration of aeronautics and promotion of state aid to the industry. The 44 delegates represented a total of fourteen states.

An important event preceding the Miami races is the New York-Miami cruise of amateur pilots under the auspices of the United States Amateur Air Pilots Association. Taking off from the Aviation Country Club of Long Island field at Hicksville on Jan. 4, the fleet will go to Washington, Richmond, and Pinehurst. On Jan. 6 the cruise will visit Columbia and Savannah, spending the night at St. Simon's Island, where the participants will be entertained by Howard E. Coffin. Miami will be reached on Jan. 7 by way of Daytona.

Following the races, the Annual Florida State Air Tour will be held, leaving Miami Jan. 11, returning on Jan. 21.

The 1932 King's Cup Race around Great Britain will not exclude so called professional pilots, as was the case with the 1931 event. The restriction to amateurs and the definition of that term aroused an intense controversy, especially as Royal Air Force pilots were able to qualify as amateurs, giving them an obvious advantage. Making the event an "open" one is accompanied also by lifting of all restrictions against ownership of type of aircraft which may be entered, the only stipulation being that the entry must satisfy judges that planes will cover the course at a speed of at least 110 m.p.h.

Transport changes

A number of route changes and additions were made by the transport companies in recent weeks. Pan American on Dec. 5 began operating between Havana and Central America by way of Merida, Yucatan, instead of Cozumel. Late in November it put into service the new Sikorsky S-40, named the American Clipper. The sister plane, denominated the Carribbean Clipper, was to go into service about the middle of December, and a third S-40 was ordered.

During the first nine months of this year Pan American carried 31,202 passengers and 1,338,931 lb. of air mail and express; its 102 transports were flown 9,300,728 passenger miles. Mexican Aviation Company, division of Pan American, is affected by a recent announcement that the hitherto non-operative Mexican rule providing that all transport planes in that country be manned by Mexican pilots would go into effect Jan. 1. Mexicans have been employed as co-pilots for some time.

Another addition is the inauguration by Eastern Air Transport of service between Atlanta and Savannah by way of Augusta, Ga., and between Atlanta and Charleston also by way of Augusta. Thus are linked the east and west divisions operated by E.A.T. and Augusta is connected to each of them.

American Airways began operating Nov. 25, an additional round trip daily between Cincinnati and Chicago by way of Indianapolis, and between Louisville and Cleveland by way of Cincinnati, Dayton, Columbus and Akron, making three round trips daily on all these runs. Century Airlines has introduced a new non-stop service between Detroit and Chicago. This service is operated four times a day in addition to the regular four schedules which call for stops at South Bend, Indiana.

Century extends

Century Pacific has extended its service from Los Angeles to Yuma and Phoenix, Ariz., and on Dec. 1 began operating between Phoenix and Tucson, paralleling American Airways' transcontinental route. American Airways retaliated by inaugurating a three-times-daily shuttle service between Phoenix and Tucson, and plans to protest Century's operation before the Arizona Railroad Commission. Southwestern Century is reported under organization in Dallas, to connect with the other two Century lines and push through a transcontinental service.

At the close of its first full month's operations of the San Francisco-Los Angeles high speed service with Lockheed Orions, Varney reduced the fare from $25 to $18.95, the same rate charged by other lines, and slightly below the railroad fare. Obtaining a concession from the Mexican government, Varney has opened an eight-trips-daily service between San Diego and Agua Caliente, with two trips each day to Ensenada.

Wedell-Wilhams Air Service has discontinued daily operations between New Orleans and Dallas.

Operation of Curtiss-Wright's daily air ferry service linking three airports in the New York Metropolitan area has been discontinued for the winter, but reduced operations will be continued on week ends. During the three months of operation, starting in September, the ferry carried 3,805 passengers, mostly sightseers, on an hourly schedule.

Though transport lines showed a decrease in patronage during the first six months of this year as compared with 1930, the figures for the first nine months are distinctly encouraging. They show, according to the reports submitted to the Aeronautical Chamber of Commerce, an increase of 6.5 per cent over the corresponding period for last year. A new monthly record was established in September, when 62,419 individuals were carried.

Express up, rates down

The same report shows that during July, August and September express shipments amounted to 296,105 lb. In the same period last year express totaled only 81,022 lb. Century Air Lines has introduced an express service, including pick-up and delivery.

The Railway Express Agency has announced radically reduced fares for express service over the six lines with which it has contracts—United Airlines, American Airways, Western Air Express, Northwest Airways, National Parks Airways, and Pennsylvania Air-

lines A 10-lb. package sent between New York and San Francisco, for instance, now costs $13.60 instead of $26. Tariffs between some cities are reduced to about 20 per cent of the former rate.

K.L.M., the Dutch Air Transport concern, carried 20 per cent more mail (about 480 lb. each trip) on its Amsterdam-Dutch East Indies service during October, the first month of operations on a weekly basis, than under the previous monthly schedule.

All but executive offices of Transcontinental & Western Air have been moved to the company's new base at the Kansas City (Mo.) Municipal Airport. Transamerican Air Lines Corporation moved into its new $75,000 sales service base at Chicago Municipal Airport on Nov. 16.

H. G. Watkins, leader of the British Arctic Air expedition to Greenland to study meteorological conditions on the Greenland ice cap, reports that scheduled operations over the sub-Arctic route will be impracticable until multi-engined planes of high speed and capable of clearing the blizzard strata over Greenland have been provided.

Seventy-three tons of gold, valued at $50,000,000, were shipped to Paris from the Netherlands by air during October. Bullion shipments have been bringing the European airlines a good income for many years.

Mail payments

During the July-October period (one-third) of the present fiscal year of the Post Office Department, a total of $7,471,033.38 has been paid the mail operators. This represents about 38 per cent of the total appropriation of $20,000,000 for the year. Payments have been averaging about $1,867,800 per month, as compared with a monthly average of $1,413,800 for all last year and an average of $1,560,000 available for each of the next eight months if the creation of a deficiency is to be avoided. At the close of the fiscal year last June there was a surplus of approximately $1,000,000 from the appropriation of $18,000,000.

Imperial Airways mail volume continued to grow in the third quarter. The company carried 34,061 lb. during July, August and September, as compared with 26,248 in the same period a year ago and 27,996 in the second quarter of 1931. The Indian government contract with Imperial Airways for carrying mail between Karachi and Delhi expires December 31, but the service is to be continued, at least temporarily by light planes of the Delhi Flying Club. The Air Ministry is projecting a number of large flying boats capable of being operated on trans-Atlantic services.

To the 17,500 miles of Federal airway in operation on July 1, there are being added 1,123 miles. The New Orleans-Atlanta Airway is to go into operation early in January, the lights having been put in use December 18. Surveys are being made on the Nashville-Dallas route and construction has started on a $70,000 communication and radio beacon installation at Spokane.

With the federal government planning to limit its airways to 25,000 miles, the need of State operated airways to supplement the federal system is being emphasized. At the present time Pennsylvania is the only State which has installed a lighted airway, its system comprising 26 beacons on 370 miles. Idaho has been active, but only to the extent of providing a network of unlighted auxiliary fields.

A new type of air navigation map is being developed by the Hydrographic office of the Navy Department. This is for dirigible operation and corresponds to the mariners' charts used at sea, showing instead of soundings the elevations of the terrain and other important information such as lights, fields, railroad lines, and important roads. As a phase of the long-existing rivalry between the Hydrographic office and the Coast and Geodetic Survey, the Navy has been unwilling to resigning all air mapping activities into the sole jurisdiction of the Department of Commerce.

The Hydrographic office is working also on a topographical strip map covering the north coast of South America from Trinidad to Panama. This map of the 1,300-mile airway will be completed by June 1.

Airport expanded

Relocation of a road adjacent to Central Airport, Camden, N. J., will permit the addition of 28 acres to its effective landing area. Runways are to be lengthened 1,000 ft. to 2,500 ft. and widened to 150. During the summer the concrete runways at Ford Airport, Dearborn, were lengthened by 1,500 ft. Buffalo's seaplane base has been completed and will be operated with limited facilities until ice forms. In the spring full operations will be inaugurated. The concrete ramp is 75 ft. wide, and 140 ft. long. There is a concrete apron 200 ft. wide and 342 ft. long. The Air Corps contemplates spending $3,500,000 for an advanced flying school unit for Randolph Field or $4,000,000 for rebuilding Kelly Field, now serving as the advance school. Century Air Lines has moved into its new 220x160 ft. hangar and operations headquarters at the Chicago Municipal Airport. The building provides 50,000 sq.ft. of unobstructed floor space; the doors are of the cantilever type, opening inward, the main fire protection system is the deluge sprinkler operating from roof and floor vents. All overhaul and engine repair work is done on the mezzanine floor at the rear.

The first A-T-A airport ratings have been assigned to the Lambert-St. Louis Municipal Airport and Wayne County Airport at Detroit. Both of these fields previously held the A-1-A rating.

According to the latest tabulation of airports and landing fields by the Department of Commerce there now are 1,308 commercial and municipal airports in this country. California, as usual, leads with the largest number, having 169, while New York has the greatest capital investment in airports—$17,603,000.

Personnel changes

James M. Eaton has resigned as general traffic manager of Pan American Airways to become president of Ludington Airlines, effective Dec. 15.

Richard S. Paulett, former assistant chief of the Enforcement Section of the Aeronautics Branch, has been appointed chief, succeeding Elmer McD. Kuntz, who has resigned to practice law.

Zeno W. Wicks, former Lieut.-Comdr. U. S. Navy and erection superintendent at the Goodyear-Zeppelin airdock during the construction of the Akron, has been made assistant chief engineer of the Goodyear-Zeppelin Corporation. W. H. Collins has been placed in charge of production and ship erection.

A. W. McCann, formerly comptroller of the Wright Aeronautical Corporation, assistant treasurer of the Curtiss-Wright Corporation, and treasurer of the Curtiss-Wright Export Corporation, has been named secretary and treasurer of Thompson Aeronautical Corporation. John L. Ruden, operations manager of T.A.C. since early in 1928, has been placed in charge of the company's sales and service organization. P. A. Wright, sales manager for T.A.C., has been named assistant to the president. Ralph R. DeVore, former air transport manager, has been made chief pilot. Louis M. Rawlins has been appointed manager of Logan Field, Baltimore.

Genealogy of AVIATION

AVIATION was founded by Lester D. Gardner, the first issue appearing Aug. 1, 1916, as *Aviation and Aeronautical Engineering*. In 1920 the *Aircraft Journal* was absorbed and the title became *Aviation and Aircraft Journal*, to be simplified into AVIATION in January, 1922. The chief editors have been Ladislas d'Orcy, W. Lawrance Le Page, Earl D. Osborn, R. Sidney Bowen, Jr., and Edward P. Warner.

The present staff consists of Edward P. Warner, editor; Leslie E. Neville, managing editor, Charles F. McReynolds, Pacific Coast editor, Charles H. Gale and S. Paul Johnston, assistant editors, and David J. Leisk, art director.

Statistics of the Month

Material supplementing the statistical issue, AVIATION, March, 1931, appears regularly each month. Page numbers in the statistical issue are given.

Aircraft Production from Jan. 1 to Sept. 30, 1931

(Based on Department of Commerce License Identification marks issued for Unlicensed Aircraft and Reports.)

Monoplanes		1,130
Open cockpit landplanes		822
One place	260	
Two place	543	
Three place	11	
Four place	2	
Cabin landplanes		279
One place	5	
Two place	32	
Three place	10	
Four place	128	
Five place	4	
Six place	13	
Seven to ten place	40	
Over ten place	47	
Convertibles, amphibions, seaplanes and unspecified		29
Biplanes		399
Open cockpit landplanes		364
One place	36	
Two place	141	
Three place	159	
Four and five place	28	
Cabin landplanes, four to seven place		28
Amphibions and seaplanes		9
Autogiros		52
Helicopters		2
Total commercial		1,583
Military airplane deliveries		637
Airplanes exported*		101
Grand total		2,321

†Two multi-engined planes. ‡57 multi-engined planes. §Seven multi-engined planes. *Does not include planes exported in 1931 which were manufactured prior to Jan. 1, 1931.

Scheduled Air Transport Operations

Reported to the Department of Commerce

	July	August	September	October
Passengers carried	62,435	64,957	54,799	47,665
Express carried (pounds)	80,140	144,524	85,701	65,422
Miles flown	4,139,354	4,450,406	4,212,935	4,183,793
Passenger-miles flown	13,484,110	14,158,731	12,963,713	10,587,369

Figures do not include traffic on American-operated foreign lines.

AIR MAIL AND TRANSPORT

(Page 103)

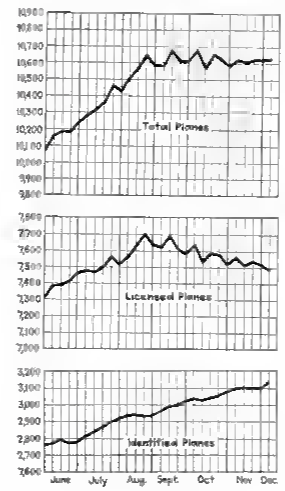
A SUMMARY of contract air mail operations for the third quarter of 1931 shows, in direct contrast to the decreases and descending curves typical of the period, increases of from 14 to 90 per cent. Scheduled mileage and mileage actually flown exceeded by 92 and 90 per cent the figures for the same period of 1930, due in some degree to additions and extensions to existing routes, while the amount paid to contractors was more than 50 per cent above the previous year's total. The greatest distance was flown between Chicago and San Francisco on route 18. Route 34, between New York and Los Angeles, had a slight advantage over the New York-Miami route for second place.

The effectiveness of the Watres act in reducing the variation in compensation among the various operators is still evident. The spread in average

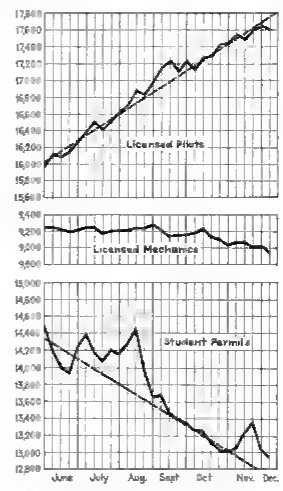
Aircraft Production from Jan. 1 to Sept. 30, 1931

	1931	1930
Commercial units	1,411	1,671
Commercial value	$5,740,089	$9,201,270
Military units	915	479
Military value	$9,517,770	$6,801,475
Total units	2,026	2,150
Total value	$15,265,856	$16,062,743

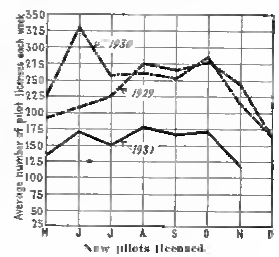
Figures based on reports to the Aeronautical Chamber of Commerce by manufacturers, largely Chamber members; amateur production not included. Values do not include engines.



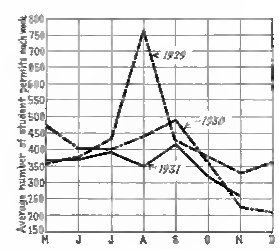
Valid airplane licenses and identifications



Valid pilot licenses, student permits in force and valid mechanics licenses



New pilots licensed, month by month



Student permits newly issued, month by month

Contract Air Mail Carried, by Routes, Third Quarter of 1931

	Scheduled	Actually flown	Per cent of scheduled mileage flown	Total weight of mail dispatched (pounds) 1931	1930	Amount paid to contractor	Average compensation per mile flown 1931	1930*
1 Boston-New York (part)	71,800	62,429	87 0	36,253	35,250	$40,050 79	$0 64	$1 24
1 Boston-Bangor (part)[1]	21,012	14,671	69 8	1 382		9 022 46	62	
2. Chicago-Memphis[2]	138,420	131,599	99 5	16,795	16,200	76 911 02	59	36
3. Chicago-Dallas	509,920	507,621	99 6	142 318	115,439	334 274 30	66	91
4 Salt Lake City-San Diego	257,592	257,351	99 8	138 707	224,528	223 943 13	63	1 71
3 Salt Lake City-Seattle	322 736	322 619	99 9	88,735	94 259	250 002 02	77	92
8 Seattle-San Diego	449,890	449 183	99 8	114,653	77 724	261 468 76	58	88
9 Chicago-Pembina	412 210	410,272	99 5	72,965	62,992	231,908 42	01	00
11. Washington-Cleveland	164 080	149 149	91 0	29,125	15 330	39 639 60	40	90
12. Cheyenne-Amarillo[3]	119 430	116,347	99 2	38,024	25,728	82 192 51	57	57
17 New York-Chicago	308,229	541,292	95 1	445,381	466,373	495,033 59	75	1 09
18. Chicago-San Francisco	1,128,872	1,128 410	99 8	439,565	467 858	1 005 146 31	89	1 40
19 New York-Miami[4]	933,046	915,526	97 8	231,124	132,528	535,291 78	58	1 26
20 New York Fort Worth[5]	410 795	391 095	95 2	66,424	12 515	234 418 00	60	36
21. Dallas-Galveston	91 222	91,153	99 0	9 976	9,061	34 959 23	52	49
22. Dallas-Brownsville	103 530	103 446	99 9	21,987	22,698	82,236 79	01	00
23 Atlanta-New Orleans	89 792	89,439	99 6	25,012	29,202	54 524 13	61	58
24 Chicago-Cincinnati	101,272	99,852	98 5	19,797	23,890	61 132 44	61	54
26 Great Falls-Salt Lake City	187,312	186,963	99 8	18,034	18 491	102,608 01	55	46
27. Bay City-Chicago	353,930	349,713	96 8	46,028	52,760	174 931 54	50	48
29 New Orleans-Houston	39 600	39,024	99 7	12,346	13 945	33 389 44	56	23
30. Omaha-Atlanta (part)	341,250	336,150	98 5	82,789	34,200	217 224 72	85	30
30. Kansas City-Denver (part)	100,096	99 552	95 6	8 450		39 820 80	40	
33 Atlanta-Los Angeles (part)[6]	549 330	545 329	99 3	68 406		472,015 86	86	
35. Albuquerque-El Paso (part)	26,710	26,710	100 0	1,282		21,109 47	79	
34. New York-Los Angeles	992,700	968,930	92 2	293,495	293 103 15	593 103 15	60	1 11
All routes	8,476,975	8,326 698	98 2	2,360,243	2,093 748	$5,614,072 17	$0 67	$0 68

*Rate for whole year. [1] Inaugurated Aug. 1, discontinued Sept. 30. [2] Extended to Memphis July 20. [3] Extended to Albuquerque and Amarillo Aug. 1. [4] Includes service to Atlantic City from New York, Philadelphia and Washington from July through September. [5] Includes service from New York to Albany beginning Aug. 1. [6] Includes service Fort Worth to Amarillo beginning Aug. 1. [7] Service inaugurated August 1.

compensation during 1930 of $1.51, reduced to 72 cents for the first six months of this year, in the third quarter dropped to 49 cents. The highest average compensation per mile flown during the third quarter of 1931 went to the Chicago-San Francisco route at 89 cents, while the new Kansas City-Denver extension of route 30 received only 40 cents per mile, as did route 11, between Washington and Cleveland, the only instances of compensation of less than half a dollar a mile. The average compensation per mile flown on all routes rose during the third quarter to 67 cents, as compared with 57 cents during the first six months of this year.

FOREIGN TRADE

(Page 168)

Exports of airplanes, engines, and parts during the third quarter of 1931 show an increase of barely ½ per cent over the totals for the preceding three months of this year. Comparison with the third quarter of 1930, however, shows a decrease of about 29 per cent in total exports. Though the number of aircraft sold abroad during the third quarter this year is a third less than in the same period of 1930, the value of these exports has dropped only a fifth since that time. Exports of engines and parts are 29 and 39 per cent less valuable than they were in the third quarter of last year.

Stable though total aeronautical exports have been this year, the important countries of destination have varied considerably. First on the list of buyers in the quarter just passed is China, fourth among the second quarter purchasers, which bought almost six times as much as the United Kingdom, second largest and steadiest customer of American aeronautical manufacturers. Netherlands, whose purchases in the second quarter were negligible, ordered engines and accessories of sufficient value to place it third on the current list, to be followed by Argentina, the largest single buyer of airplane engines. Mexico, the most important purchaser in the second quarter, now comes much further down the scale, while Soviet Russia, one-time chief customer, has been developing its own plane and engine industries and bought only accessories in small amount.

Aeronautical Exports for the Third Quarter of 1931

	Total dollars	Airplanes No	Airplanes dollars	Engines No	Engines dollars	Parts and accessories* dollars
Europe						
Belgium	13					13
Czechoslovakia	1 102					1 102
Finland	50 481			7	50 481	
France	5 099					3 099
Germany	1 825			2	1 075	750
Italy	50 137	1	21 000	6	24 685	4,452
Netherlands	80 258			11	61 902	26,851
Norway	800					800
Poland and Danzig	144					144
Soviet Russia in Europe	41 062					41 062
Spain	22 200	1	22 000			
Sweden	9 214			2	9 000	214
Switzerland	2 146					2,146
United Kingdom	109 574	2	92 646			13 928
North America						
Canada and Newfoundland	59 451	2	14 268	4	5 706	38,897
Central America						
Guatemala	1 551					1,551
Honduras	159					159
Nicaragua	2 500			1	2 500	
Panama	44,120	1	5,000	8	34 000	3 120
Mexico	45 562	8	39 026	2	3 500	3 436
Bermudas	32					32
Trinidad and Tobago	7 000			2	2 600	300
Cuba	8,458					8 458
South America						
Argentina	77 586	2	7,852	16	63,992	5 744
Bolivia	49					49
Brazil	22 322					22,322
Chile	1 409					1 409
Colombia	43 390	3	41 700			1 690
Ecuador	118					118
Peru	26,201					26 201
Asia						
British India	1 050	1	1 100			550
China	605 622	22	458 800	23	37 033	109,789
Java and Madura	19 700			3	14,956	4 744
Other Dutch East Indies	250					250
Hongkong	325					325
Japan	40 682					40 682
Syria	81					81
Oceania						
Philippine Islands	1 022					1 022
Australia	660					660
Africa						
Union of South Africa	6,708	1	4 469			2 219
Total	1 486 303	44	709 281	85	321 486	375 556

Side Slips

By ROBERT R. OSBORN

HAVING in mind the present financial status of the airplane and engine manufacturers and also the recently proposed reductions in the budget for Army and Navy aircraft procurement, we can easily imagine the following conversation when—

Three Aircraft Manufacturers Talk It Over in 1938

Scene: They meet on a street in front of a lunch wagon.

Donald—Hello, Tom, and Hello Fred! Haven't seen you fellows for a long time. Let's go in for lunch,—each fellow paying for himself, of course.

Tom—Hello! Good idea on the lunch. Let's go in. You'll have to excuse the condition of my hands, though. I was doing some painting this morning and thought I'd go out to get a sandwich while the paint dried. Can't stay long either as I've got to weld up a couple of fittings after lunch.

Fred—Tom, I'll have to come over to your place soon to find out how to do that doping and painting. I wanted to fire my doper and painter last week but he wouldn't tell me how to do the work, so I couldn't get rid of him.

Tom—I'll be glad to show you if you'll teach me how to make up ends for control cables. I'm having a lot of trouble with them.

Fred—Righto! It's a trade.

Donald—I'm surprised you're still in business Fred. I heard the sheriff sold you out last week.

Fred—No, there was a sheriff's sale for my company, all right, but nobody bid on it, so I got it back. I actually made money on the deal. When the sheriff started asking for bids, I walked out. He caught up with me a couple of blocks away from the court-house and gave me two dollars to take the company back again.

Donald—Good work. That ought to help cut down your deficit for this year.

Tom—Speaking of deficits, I've heard that there is a special ruling now that investing in aeronautical stocks can be listed as charity in income tax reports. Have you fellows heard about that?

Fred—Don't know anything about it. I haven't made out an income tax return for five years.

Donald—No, I hadn't heard that report. I'll look it up, though. If it's true, it will be the first encouraging thing I'll be able to put in the annual financial report.

Fred—Did you fellows put in bids on that last Army directive for a new left upper outer wing panel and an engine mount? I didn't hear how it came out.

Tom—Oh, yes we put in bids, but the Fly-By-Night Company underbid us and got the job. We bid $122.30, and Donald bid $122.12, and Fly-By-Night bid $94.56.

Fred—They can't make any money at that price—they'll go bankrupt.

Tom—Of course they will. They don't have any idea of what it's going to cost them to build. But what if they do go broke? There'll be another outfit to take their place before the next bid is due.

Fred—How are things moving in your factory, Donald?

Donald—Not badly. I delivered two rudders last month and have two more rudders and an aileron in the assembly line.

Tom—I was making out pretty well in my factory for a while. I was turning out one a stabilizer a month on a production order of five, but I broke the screw driver and my schedule has been out of line ever since.

Fred—About the same thing happened to me too. I was going to bid on that Navy proposal for two pilot's seats but on looking over the drawings saw that some riveting was required. I couldn't find my hammer anywhere so had to give up the idea of bidding.

Donald—Say, they tell me that Dick is making out wonderfully, that he is a millionaire several times, and is getting richer by the minute.

Fred—Yes, I've heard his plant is turning out two ships a day and at good prices too.

Tom—Yes that's so. He wrote me that he had turned out three new designs, very good ships and outstanding in performance. Said in his letter that the government paid him his development costs right away and rewarded him by substantial production contracts.

Donald—That's great. He certainly was wise to sell out his plant here and move to France, wasn't he?

Fred—Yes, he's a bright chap. I'm glad to hear he's making out so well.

Tom—Well, I've got to get back to my welding job fellows. See you again.

Donald—So have I got to get along. Say—I was just thinking, though, that there's at least one good thing that has come out of the present conditions.

Fred—What's that?

Donald—You remember that about a year ago AVIATION got down in size to a two page pamphlet?

Tom—Yes.

Donald—Well, the last issue was only one page, and they had to stop printing the "Side Slips" column.

Tom and Fred—Yes, that is something, but I thought they'd stopped printing that column years ago.

•

Had a pleasant talk with Mr. W. S. D. in Washington recently; he is being an expert on aircraft performance. He claims that the most remarkable performances are generally put out by the manufacturers rather than their products. He told of one manufacturer who had to deliver airplanes in South America, it being necessary to fly them across the Andes Mountains in the process of delivering them. Just before they started out it was discovered that their ceiling would probably be lower than the lowest part of range they had to cross, so the pilot of each plane was instructed to land near the top of the mountains and taxi across. He also mentioned the case of another constructor who was proud that his new airplane had exceeded all of his performance predictions, including stalling speed.

•

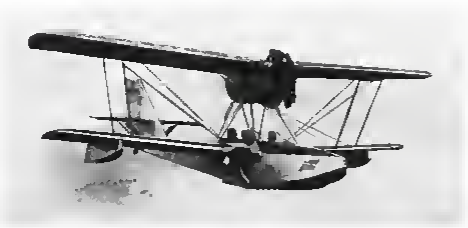
We have long realized that one of the shortcomings of aviation in general was that we didn't have enough clubs and fraternal organizations to join. However, being busy with this and that we didn't do much about the problem, and are glad to say now that Mr. D.L.H. of New Britain, Conn., has helped us out by suggesting another club to organize. Readers will now consider the club formally organized, and anyone wishing to join can do so by mailing us the $10 initiation fee, and saying nothing more about it. Mr. D.L.H.'s letter follows.

"I believe that there are a number of mythical clubs extant among the flying fraternities, i.e., The Caterpillar Club comprised of those who have saved their lives by bailing out, the Bonehead Club comprised of preoccupied individuals who have neglected to put down the wheels of an amphibion prior to landing on terra firma, et al.

"Even in this day of clubs, fraternities, associations and other manifestations of the joining spirit, I think there is perhaps room for still one more. So far as I know no one is as yet eligible to belong. However, if someone were to become eligible it would seem a pity indeed if the club were not organized and ready to receive him. The organization to which I refer might be known as the "Ostrich Club" to which only those who have attempted to take off in a folding wing plane *with the wings folded*. Of course there might not be a need for such a club for some time to come, but it will be needed sooner than one would expect, what with the slipping of important details from the mind in these days of hustle and bustle."

FLYING EQUIPMENT

All-steel amphibion



The all steel amphibion built by the Edward G Budd Manufacturing Company from American Aeronautical Corporation designs

ALTHOUGH stainless steel has been used extensively for certain airplane parts, and in one case, for a complete wing structure, the first use of this material in this country for an entire airplane, is in the BB-1 amphibion, built by the Edward G Budd Manufacturing Company, of Philadelphia, from designs developed by the American Aeronautical Corporation of Port Washington, New York In general appearance the machine is similar to the model S-31 Savoia-Marchetti, although the power has been increased, and accommodation provided for one additional passenger

In the electric welding of stainless steel, as is often the case in connection with other alloys, the strength and the corrosion resistance of the joints are dependent upon the length of time required to make the weld As a general rule, the shorter the time required to fuse the metal, the more satisfactory is the weld The apparatus developed by the Budd Company uses a very high current at low voltage for a relatively short time interval The actual heating and fusing takes place in a highly localized area, and the overall strength of the metal and its resistance to corrosion, are but slightly affected The equipment required is portable, self-contained, and may be operated safely by ordinary shop labor

In developing the design for the BB-1, the number of individual rolled sections required were standardized and cut down to a minimum Only four basic shapes are used in the design For example, the deep U section used for the flanges of the spars is also employed for stiffeners for the hull plating A smaller U section from which the ribs are made, also finds use as stringers in the hull bottom The wing spars are of the open lattice type, with all connections spot welded to small flat gusset plates Ribs are of the Warren truss pattern, having both cap and web members of the smaller U section. Drag bracing is of the same design as the wing spars Toward the tips, the drag members are cantilevered outward from the rear spar to carry the aileron hinges

The hull is of monocoque construction, with flat side plating from gunwale to chine and with the V bottom formed of flat plates Side, deck, and bottom plates were made up with stiffeners separately, and the assembly made by welding the several units together along the keel chine, and gunwale The hull was made watertight by running solder into the seams after welding

One of the most interesting features of the experimental machine is in the use of stainless steel wire screen to replace fabric on the wing and tail surfaces For the trial flights the entire machine was fabric covered, but work is now progressing on the replacement of the fabric with screen A special dope is used to fill the openings of the screen and make the surface air and water tight The appearance of the covering is unusual for the surface is practically transparent, leaving the entire interior structure visible for inspection The weight of this type of covering is said to be about the same as that of standard doped fabric.

The design in general is a four-place open cockpit, biplane amphibion, powered with a 210 hp Kinner engine, arranged as a tractor in a nacelle hung below the center section of the upper wing The general specifications as given by the manufacturer are. span, 34 ft. 1½ in , length, overall, 25 ft. 8¼ in , height overall, 10 ft. 3 in , wing area (including ailerons) 292 sq ft , weight empty, 1,749 lb , gross weight, 3,300 lb wing loading, 9.1 lb per sq ft , power loading, 12.7 lb per hp

The R.A.F. Bristol 118

THE British Air Ministry has recently released specifications on a general purpose military airplane designed and built by the Bristol Airplane Company, Ltd This type is particularly well adapted for use by the Royal Air Force whose planes, distributed throughout the British Empire, are called upon to perform a variety of missions The machine is designed for a crew of two, a pilot and a gunner-observer, and is adaptable for photographic or bombing purposes, or may also be fitted with complete radio equipment for general army cooperation It may be used as an ambulance airplane with space available for two stretchers

The general purpose Bristol biplane

The machine is a two-seater single-engined staggered biplane, whose structure is entirely of steel It is of particular interest in that a combination of tubular and built up members is used both in fuselage and wing construction The fore part of the fuselage including the gunner's cockpit is built of round steel tubing Aft of the gunner's cockpit, to a point just under the front spar of the stabilizer, all structural members are built up of high tensile steel sections riveted to steel joint plates The stern wedge, that is, the entire rear section of the fuselage aft of the front stabilizer spar, is of similar construction, but is easily detachable as a unit from the fuselage proper, by the removal of four bolts

The wing spars are of fabricated steel strip, with steel tubing used for drag bracing Ribs are also of steel, of a U section, and the entire structure is fabric covered. The interplane bracing is of a modified Warren truss type, notable for the use of a compression strut of relatively large size, running upward and inward from the front spar strut point of the lower wing to the rear spar center section connection of the upper wing This member apparently acts both in tension and compression, and eliminates the use of all exposed wires in the cellule

The power plant is a nine-cylinder air-cooled supercharged Jupiter engine, developing between 525 and 575 hp at altitudes from 11,000 to 13,000 ft.

Air Corps The Douglas observation plane

Curtiss A-8 attark airplane

The N B-8 Trainer

Nicholas-Beazley training plane

ONE of the requirements of recent light airplane competitions in Europe has been that the wings of all competing airplanes be capable of folding back to permit the storage of the machine in ordinary automobile garage space Although this idea has never had wide acceptance in America, the folding wing is one of the features incorporated in the new NB-8 Trainer, built by the Nicholas-Beazley Airplane Company, Inc , of Marshall, Mo The parasol-type monoplane wing is strut braced in such a fashion that both tip sections can be folded backward about a hinge located at the rear spar at the center section Tests have indicated that the wing may be unfolded and locked into place in about five minutes With wing folded, the machine may be stored in a space 11 ft. wide 8 ft high and 23 ft long

The steel tube, fabric covered fuselage is wide enough to accomodate side by side seating for two persons in the cockpit Tail surfaces are built of alloy steel tubing, but the wing is of wood Both are fabric-covered The landing gear is of the split-axle type, equipped with both air wheels and oleo shock absorbing units All metal fittings are chromium plated

The power plant of the NB-8 is an Armstrong-Siddeley Genet Mark 2, five-cylinder air-cooled, radial supercharged engine The British rating of 88 hp at 2400 r p m corresponds to an American rating of 80 hp at 2310 r p m Townend ring cowling and wooden propeller are standard equipment. The general specifications as given by the manufacturer are as follows Span 37 ft 6 in , length overall, 26 ft 3 in height overall, 7 ft 9 in weight empty, 717 lb useful load 493 lb gross weight, 1210 lb wing loading, 6.4 lb per sq ft , power loading, 15 lb per hp

The Douglas observation airplane

THE Douglas Airplane Company of Santa Monica, Cal , has recently delivered to the Air Corps for test purposes an experimental type of observation airplane designated officially as the YO-31. The machine is a wire-braced monoplane of the gull-wing type designed primarily to afford the widest possible angles of vision for both pilot and observer

The YO-31 is powered with a Curtiss-V-1570-C Conqueror liquid-cooled engine of 600 hp

Curtiss A-8 attack plane

THE trend away from biplane types for military purposes is well illustrated by the new Curtiss A-8 attack airplane, of which thirteen units have recently been ordered by the Army. Although detailed specifications of this airplane are not available at the moment, it is clear that the designer has drawn heavily upon recent racing experience Fuselage shape, wheel fairings method of wing bracing, etc , bear a strong resemblance to those employed in the machines which have succeeded in raising speed records at the National Air Races of the past two years The fully-inclosed cockpits which are now becoming the vogue in the design of high speed transport airplanes are also in evidence Another unusual feature is a trailing edge flap, apparently independent of ailerons

The machine is powered with a liquid cooled Curtiss Conqueror engine of 650 hp Its armament consists of six machine guns and one large bomb

AIRPORT MANAGEMENT

Cleveland port controls traffic by radio

AIRPORTS through which an increasing amount of transport traffic flows are concerned with means of controlling that traffic so that congestion and attendant risk of accidents in the air and on the ground will be minimized. One of the most elaborate control systems has been in operation for more than a year at the busy Cleveland Municipal Airport. This system is based on radio phone unit operated from the control tower where a man is on duty at all hours.

The set is rated at 50 watts, and operates on 15 watts at a frequency of 278 kc. The antenna consists merely of a single wire stretched between the top of the control tower and a support on the roof of the building. Communication usually may be maintained up to fifteen miles from that point, though with favorable weather conditions this range is extended. The port also has two standard shortwave receiving sets operating on 20-150 m which are used when occasion demands for getting reports from the planes of two transport companies whose instruments are effective in that range.

The procedure is for the control tower man to contact arriving planes and give them information regarding atmospheric and physical landing conditions particularly warning them against the presence in the air or on the ground of planes which might be a menace, and to contact planes ready to leave inform the pilot about the wind direction and velocity, and the number of planes on the ground and in the air which he should look out for. The tower man also gives the plane pilot permission to taxi out for the take off, contact is maintained until the pilot has flown out of the airport zone. If the plane has a two-way set all conversations are acknowledged by voice, otherwise acknowledgment is made by blinking the lights at night, or in daylight by kicking the rudder, if on the ground, or rocking the plane, if in the air.

The approaching planes are picked up when they get within fifteen miles of the port. The tower man does this by following on a position map the progress of each transport approaching Cleveland, as indicated by periodical radio reports from the pilot to the Cleveland dispatcher of each company. The dispatcher in turn notifies the tower. He estimates just about when the plane will enter the fifteen-mile zone and begins his broadcast, repeating his information until he hears the pilot's voice or sees the plane. Constant communication is maintained until the pilot begins his glide into the field. Once the machine has settled on the ground, conversation may be resumed to warn against another plane landing just behind the first one, or a similar contingency.

There are on record at least two cases where transport planes have been landed at Cleveland through a 50-ft fog layer with the help of information broadcast from the tower. In each case the tower man advised the pilot of his approximate position in regard to the airport boundaries and his altitude, judging by the sound of the engines. There have been many instances when possible serious accidents have been averted through emergency information, such as notification of two planes flying close together.

New runway lights at Port Columbus

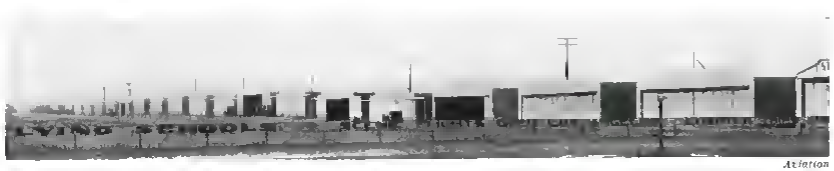
A NEW type of runway illumination has been installed at the Port Columbus field with satisfactory results. The field has all the conventional lighting units employed in the usual way, but the airport encourages the practice of depending on the floodlights merely for showing the presence or absence of obstructions on the field, such as a plane which has not taxied to the hangar line. For actual landing the port has provided flush type lights which outline the edges of the concrete runways.

There are 77 units in the system, spaced 150 ft apart and flush with the surface of the ground. The lamp housing is ¼-in. cast iron alloy, designed to dissipate the heat of the enclosed 60-watt lamp, without ventilation. The units are water tight and mounted in concrete. The lenses are one-piece, convex, heat resisting glass, designed to direct at least 85 per cent of the light upward and to withstand an impact of 30,000 lb. The current is 115 volt multiple circuit supplied through a flexible cable laid underground. 100-watt lamps may be substituted for the 60-watt lamps should the latter prove insufficient. There is no attempt to connect the lighting with the wind key for automatic indication of wind direction, all control being manual, and the lights on all runways being turned on simultaneously.

Dycer's individual hangars successful

OPERATIONS at the new Dycer Airport in Los Angeles in the last half of the year indicate that a profit is within reach of the commercial airport, despite prevailing economic conditions, when adjustments in tune with the times are made. All rates and charges were placed at the minimum possible point at which a reasonable profit could be made, and within a few weeks of the field's opening under the Dycer management, (the field formerly was operated by Aero Corporation of California) half of the capacity of two large hangars had been rented and all of the 24 individual hangars were taken.

The aspect which would stand serious consideration by other operators of Dycer Airport is the provision of individual hangars, chiefly for private pilots. These seem to be good investments from the point of view of the management and attractive to the non-professional and the individual commercial operator. Each is rented for $20 per month and as each cost only $1,000-$1,500, the return on the investment is impressive. Upkeep is low and practically the same as for any small wood structure, while danger from fire loss is minimized by the spacing between units.



The 24 individual hangars at Dycer Airport, Los Angeles, all occupied

The individual hangars are approximately 50 ft. wide, 35 ft. deep and 13 ft. high, large enough to accommodate machines up to and including a single-engined Stinson or Fokker. Half are rectangular and the balance T-shaped. There is sufficient room in each type for work bench and storage of tools and supplies, while in the rectangular units the rear corners may be partitioned off for office and shop space. The simple but satisfactory construction is emphasized by the fact that the floor is natural dirt. The doors are of the overhead support, track roller type. A complete repair shop is available at one of the larger hangars on the field and planes may be taxied to it or towed there by a tractor for adjustments.

This successful exploitation of facilities for the non-professional owner is supplemented by the usual commercial operations, which include taxi flying, student instruction and short hops, all offered at rates considerably reduced from those in effect a year ago.

HANDBOOK OF AERONAUTICS, *edited by Squadron Leader C. G. Burge, Capt. J. L. Pritchard, and Lieut. Col. W. Lockwood Marsh, Gale & Polden, London, 702 pages, $8.*

THIS is the first serious attempt at a handbook of aeronautics since the publication of A. W. Judge's work about ten years ago. By curious coincidence however, its appearance is almost synchronous with that of the first American venture in the same field, which is being published just at the time of this review's appearance. Squadron Leader Burge and his two technical associates have, of course, worked essentially from the British point of view, although much that they have covered is international and treated in a fashion very useful to readers in America or anywhere else. They have followed the usual practice of handbook compilers (although one from which the authors of the American book just referred to have departed) in confining their own function to editorship and collecting a number of experts to write as many chapters on their specialties.

Thus, aerodynamics is treated by E. F. Relf of the National Physical Laboratory, materials by Lieutenant Colonel Outram, the Director of Aeronautical Inspection, and engines by A. H. R. Fedden of Bristol Jupiter fame. Other chapters cover performance design and construction, airscrews, air survey and photography, instruments and navigation, wireless (or radio, to use the American equivalent), meteorology, and airship design. The book is by no means limited, therefore, to the aircraft designer, but extends out into a miscellaneous field of operation. Dimensional standards and descriptions of equipment are given in the usual detail, and of course relate entirely to British practice. The compilation of parasite resistance data is particularly excellent, while the chapter on aerodynamics proper goes rather beyond what is feasible for a handbook in reproducing an elaborate series of diagrams of dynamic stability characteristics. It is very difficult to summarize the quality of a volume of such varied authorship, but, as would be expected from the distinguished backing of the council of the Royal Aeronautical Society, the general level appears to be high, subject to the serious disadvantages for American readers of the differences in national practices and standards.

PILOTS' HANDBOOK, *Pilots' Handbook Publishing Company, Los Angeles, 1931, 425 pages, $7.50*

"HANDBOOK" is a somewhat misleading title for a volume 10½ x 7 in. and almost 2 in. thick. Most of its contents are really intended for study at home, and in fact the navigational section, which is the largest of the several parts that make up the book, is equipped with questions and answers to be used in preparing for the Aeronautics Branch examination. That part of the book is edited by Comdr. P. V. H. Weems and is based on his well-known system. A much shorter section on meteorology, introduced by a number of particular examples of how meteorological service has been supplied on certain famous flights, is by Mr. Reed, senior meteorologist of the Weather Bureau.

From this introductory textbook material the compilers turned to airway and airport information, listing 129 air routes within the United States and giving detailed lists of distances, courses, and land-marks, somewhat like an automobile blue book's description of a highway route for each one. It is an interesting innovation, but it seems probable that most pilots will prefer to depend on maps rather than on route descriptions. In the same way all American airports are listed, with an indication of how far they are from the city and in what direction and with their size, but with no sketches. A pocket in the back of the book contains 21 sectional maps covering the United States, showing the principal airways and airports, but very crude in form as compared with the governmental productions, and with some notable omissions of important features. A short chapter on the present status and trend of the development of aviation and on the use of radio is contributed by Lieutenant Hegenberger, who navigated the first plane into Hawaii from the Pacific Coast.

A couple of hundred pages are given over to miscellaneous data such as reprints of Department of Commerce rules for approving repair stations, lists of approved type certificates, and a directory of manufacturers of aircraft and their accessories,—the latter being highly inaccurate in some of its sections, and including companies that have been out of business for years. For some unexplained reason the table of contents is hidden away in the back of the book, a practice common in French and German publications but hitherto unknown in the United States.

AN INTRODUCTION TO AERONAUTICAL ENGINEERING, VOL. II, STRUCTURES, *by J. D. Haddon, Gale & Polden, Ltd., London, 1931, 128 pages, $2, approx.*

IT IS several years now since a thorough-going book on structural theory has come from Great Britain. The present effort could hardly compete with Pippard and Pritchard's book of several years ago, having only one quarter of its bulk, but even as a brief introduction and summary of the present state of the art it is lacking. It is good on detail design especially of metal spars, but particularly weak on the ordinary theory of the strength of materials. The three-moment equation, for example, is completely omitted and in the discussion of loads on an airplane structure there is no mention of the effect of any maneuver except a simple turn. On the other hand, there is an exhaustive analysis of the method of calculating the structural properties of a corrugated strip-steel spar of highly involved form, some very sound although not particularly advanced information on fitting design, and a group of excellent

illustrations of metal spars of British origin To top off with there are 67 sample problems, most of them comparatively simple. On the whole, it is a very badly balanced book It is too mathematical for the average airplane mechanic who would like to get a general sense of the soundness or otherwise of structural arrangement (although he may get some very useful information on the design of spars of thin metal sections), and it is not mathematically complete enough for an engineer.

AVIATION OF TODAY, *by J. L. Nayler & E. Ower. Frederick Warne & Company, London, 491 pages, $6.*

THIS is the first serious attempt by thoroughly competent men at an all-inclusive book on aeronautics for the general reader. It is a remarkable thing that it should not previously have been attempted. There have been innumerable popular expositions of how the airplane flies and of the behavior of the aeronautical power plant, but no one else has undertaken to cover the history, the evolution of the design of airplanes and airships, the general problems of pilotage, and air transport and the other uses of aviation, all in one set of covers. As might be expected from the identity of the authors however (Mr. Nayler is the Secretary of the British Aeronautical Research Committee, corresponding to our N.A.C.A., and Mr. Ower is his assistant), the bias is still heavily on the technical side, and the applications of the airplane receive only about 60 pages out of a total of nearly 500.

It is in every respect an admirable volume for the British reader. From his point of view nothing better could be asked. For the American it of course suffers in that practically all the examples and practically all the illustrations are taken from British experience. Of the 50-odd admirably executed color plates only eight are of non-British origin, only two of them American, and the 100 or more full page photographs of aircraft and their uses show an equally strong preponderance of British subjects. Except for this somewhat parochial character it would be difficult to make any criticism of the book's suitability for the use of the intelligent lay reader for whom it is designed.

NAVAL AIR PILOT, *Hydrographic Office, Navy Department, Washington, D. C., 1931. approx. 300 pages, loose leaf.*

THE Naval Air Pilot is a compilation for the special use of naval aviators and containing some information of no possible application except in naval operations but available also to civilians. It is a collection of loose-leaf material of the standard size of the Department of Commerce airport bulletins and part of the contents were drawn directly from the Department of Commerce. Most of them, however, are of naval origin. There is some general information on federal radio facilities and their use, tables for making drift corrections for cross winds, and lists of Coast Guard stations on the Atlantic and Gulf Coasts. The really original feature, however, and the one which represents the largest amount of work by the Hydrographic Office is the collection of some 60 bulletins on landplane and seaplane facilities at many coastal points. Seaplane anchorages are clearly shown on charts printed in three colors, and the charts are accompanied by tabulation of data on tides, currents, servicing facilities, and so on. For guidance there are photographs showing either the anchorage or the local airport or both. For guidance to the landplane pilot the Navy information hardly equals the airport circulars furnished by the Department of Commerce, but for travelers by seaplane the collection (constantly being amplified by new Hydrographic Office leaflets to fit into the same binder) has no competitor.

BLIND OR INSTRUMENT FLYING, *by Howard C. Stark, (privately printed by Howard C. Stark, P. O. Box 1 Newark, N. J.), 1931, 30 pages, $1.*

COMPLETE absence of theory, but direct instruction as to the use of modern aircraft navigational instruments, characterize this instruction manual intended for the transport pilot. The author admits that the book will not teach instrument flying any more than a book on how to fly would teach an uninstructed person to become a pilot, but he does present in a simple and direct manner the facts about instrument flying gained from long practical experience. It should prove interesting to amateur and valuable to the expert flyer.

AIRPLANE CONSTRUCTION AND REPAIR, *by John G. Younger. McGraw-Hill Book Company, New York, 1931, 418 pages. $3.*

IN this volume, designed for use as a text book for schools giving courses for airplane mechanics, the author has achieved a combination of theory, practice, and reader interest unusual in books of this character. Not only is the student mechanic given a very thorough insight into the details of his trade, but he is also introduced to enough theoretical aerodynamics and mechanics to give him an understanding of underlying principles. The book is copiously illustrated with well chosen photographs, and clear cut diagrams. The textual material of each chapter is supplemented by practical exercises and experiments to be conducted by the students. Each chapter closes with a set of review questions and a complete bibliography for those who wish to go into further detail. The chapters on steel and welding methods were contributed by Mr. N. S. Ward. The book would be a valuable addition to the library of anyone who has to do with the repair and upkeep of airplanes.

THE PROBLEM OF VERTICAL FLIGHT, *by P. C. Grose; General Publishing Company, McComb, Ohio, 1931; 128 pages.*

PROCEEDING from a publisher hitherto unknown in the aeronautical field and sent out in a binding and format suggestive of a dime novel, the quality of Mr. Grose's book belies its appearance. It is the first systematic study of the helicopter in book form since Margoulis' volume on the theory of vertical flight some eight years ago. Mr. Grose has nothing to say on the theory of the type and gives no references to previous publications, but he makes an excellent classification of helicopter types and a comparative study complete with many badly reproduced illustrations, of the machines that have been built in recent years. The various machines are analyzed under the headings of their various essential features with comparison of the means adopted for securing forward motion for stabilizing, for attaining safe descent without power, and so on. Within its limited scope and purpose, the book is reasonably clearly and interestingly written.

THE LIGHT AEROPLANE MANUAL, *by F. D. Bradbrooke. Chapman & Hall, London, 1931. 251 pages, $3.25, approximate.*

MR. BRADBROOKE is C. G. Grey's assistant on *The Aeroplane*, where he specializes in the pilot's point of view and in critiques of new airplanes. He follows the pilot's point of view again in the present book, although he pays deference to tradition with a few introductory chapters on the theory of flight and the detailed design of airplanes. They are much less heavy than the usual treatment of that subject, being enlivened with a very attractive humor and a casual and conversational style which continues throughout the book.

The sections more directly concerned with flying, such as those on instruments, on what an airplane can do and on sport flying, are similarly attractive in style and sprinkled with anecdotes. They contain a great many useful tips on getting the most out of a plane either in ordinary flight or in racing, and the book is to be judged as a collection of notes rather than as a complete text.

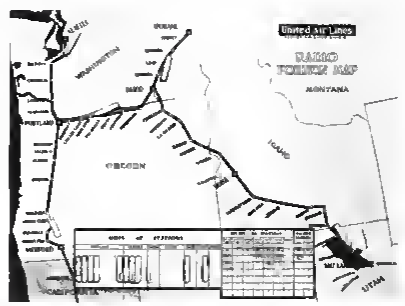
The volume can be read with almost as much profit and enjoyment in America as in England and it shows far less concentration on British events and indifference to the rest of the world than do many volumes of English authorship.

TRANSPORT

Operations and Traffic Management

Airline radio position map

AT PORTLAND (Ore.) Airport, United Air Lines is using a map with several interesting features to indicate location of pilots and planes at airports, or along the airways as reported at intervals by radio. The system is based on individual tags for each plane and for each pilot. Each tag is hung individually on hooks in ruled spaces at the bottom of the map, each space indicating a base, when the plane or pilot is not flying.



United Air Lines radio position map which indicates the position of planes along the routes

When one of the 25 planes takes off, the plane tag is removed from the space bearing the name of the airport from which the plane departs, and the tag for the pilot is removed from the pilot rack and affixed to the plane tag. As the position reports come in, at ten-minute intervals the tag is moved along the airways to its destination. The arrows have magnetic bases and the map a metal base so that the arrows may be moved along the route easily and accurately.

This map gives an overall picture of the plane operations at all times. The information is useful to the traffic department as well as to the operations men and enables dissemination of information without interfering with the work of the radio operator.

Colonial Air Transport and Colonial Western divisions of American Airways at Newark Airport keep track of plane positions over the New York-Boston and the New York-Albany-Cleveland routes by means of maps ruled off in squares and a pair of buttons for each plane, the plane's number appearing on the face of the buttons. A pilot en route reports periodically and announces his position by stating the square he is in. The radio operator places one button on the point where the plane is reporting and another at the point where it last reported, the difference indicating the progress being made.

Traffic promotion concentrated

EFFECTIVE Oct. 1, Transcontinental & Western Air made a fundamental realignment of departmental responsibilities by transferring from its traffic to its operating department the work of maintaining the company's mail and express reports, and attending passengers from the downtown terminals to the airport passenger stations. This adds responsibilities to the operating department, but relieves the traffic department of work which was consuming about 50 per cent of its time.

The change provides a more logical and efficient arrangement. The additional effort the traffic department has been able to place on patronage promotion is responsible largely for a slight increase in traffic in October over previous months. Though traffic agents place passengers on the conveyances which carry them to the airports, traffic representatives are not allowed under strict orders to go near the airport except for special reasons. The operating department's responsibility starts with the arrival of the passengers at the port and continues until they leave the company's terminal at their destination.

Limousines satisfactory for port-city transportation

LEHIGH LINES and Transcontinental & Western Air have substituted sedans and limousines for buses for airport-downtown passenger transportation in New York City. In line with practice common to practically all lines today, the vehicles are operated under an agreement with a local contractor and not by the transport companies themselves. The income of the owner and operator of the sedans consists of the 75-cent fare he collects from the passengers, the fee which the airlines have established. The main obligation of the lines is to direct as much of its passenger traffic as possible to the airport by way of the automobile service.

The two companies using cars consider them an improvement over buses. They are often seven to twelve minutes faster in traffic and seem to produce a better psychological reaction among the passengers than the large, seldom filled buses. They are more economical to the contractor, and fit satisfactorily into the general economical program because they accommodate as a rule about all the passengers originating at any one point. Should the number of passengers exceed the capacity of the car, others may be readily added.

Century Air Lines likewise, is using seven-passenger limousines.

32-page booklet describes airline

UNITED AIR LINES is publishing a 32-page booklet, done on the outside in three colors and on the inside in two. The booklet is interesting to passengers, among whom it it distributed since it describes the equipment, personnel operating practices, radio telephone and weather reporting system, and other facts about the line. It is distributed by traffic agents, also, to potential passengers and is being widely circulated in connection with the company's national magazine advertising campaign. These advertisements are designed to appeal to the business man to use aircraft in scheduled operation, they emphasize the comfort as well as speed of modern air transports.

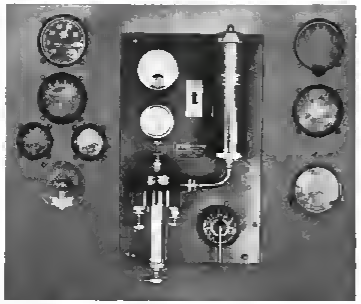
Brief historical sketches outline some of the important events which have occurred at various points along the routes, thus adding to the interest of the traveler in the views from the plane. Air photographs of cities flown over and maps of individual routes as well as of the entire United system contribute to the passengers' enjoyment of the trip.

AIRCRAFT AT WORK

Socony test plane speeds sales program

FOR sales promotion and service tests of its aviation products, the Standard Oil Company of New York, which has as its territory, the State of New York and all of New England, has been making effective use of a Bellanca Skyrocket (Wasp engine) and a Pitcairn autogiro. The gyro was used for a special sales promotion and test campaign up to the early fall, when it was sold and the Skyrocket acquired.

A conspicuous example of the plane's value was afforded by the company's experience in presenting a special sales program for the winter throughout its territory. There was obvious advantage in being able to launch a program simultaneously in all districts, and within shortest possible length of time after it had been drawn up. By means of the plane, the sales promotion manager and assistants were able to visit the sixteen districts outside of the metropolitan New York area, and contact all representatives in five days. The same trip would have required about one month under ordinary circumstances. The plane stopped at sixteen airports, traveling about 1,250 miles in ten hours of flying on five consecutive days. Few hops between airports were more than an hour in duration. For instance, the party traveled 160 miles from Burlington, Vt., across the White Mountains to Portland, Me., in 65 minutes. The 65 miles between Buffalo and Rochester were covered in eighteen minutes. The party included K. L. Bridges, sales promotion manager, R. L. Anderson, lubricating engineer, Capt. Julian S. Dexter who piloted the plane, and Wally Holbrook, mechanic.



The Moto Vita on the instrument board

For test purposes a special instrument board has been installed on the rear wall of the cabin the three rear seats being arranged to permit easy observation of the dials. On this instrument board are altimeter, electric tachometer a clock with stop watch adjustment, Moto Vita unit, air temperature indicator, thermocouple unit, electric oil temperature indicator for oil at the intake, and an oil pressure indicator.

The main units are the Moto Vita and the thermocouple. The former is well known in the automotive world but this is one of but two installations on aircraft. By it is measured the amount of combustible materials present in the exhaust gases. It is connected through a selector switch to all cylinders, which may be tested singly or together. The thermocouple is connected to three cylinder heads and one cylinder base.

The practice is to make a test flight with one grade or brand of gas in the main tanks and another in the 8 gal. emergency tank. Comparisons between the two are secured by switching from one to the other, and observing the relative amounts of combustibles present in the exhaust, and the temperatures set up in the cylinders during various phases of the test. The r.p.m., external temperature and oil temperature, and pressure are additional angles.

Research on an improved aviation gasoline has been aided by the flight studies already made. Operation of this company, including salaries of pilot and mechanic, depreciation over a three-year period and insurance costs approximately $41 per flying hour.

Gliders successful at Philadelphia school

THE successful thirteen months of gliding instruction at Wings Corporation Field, Philadelphia, indicate opportunities for other fixed base operators. At Wings Field, two gliders, one somewhat remodelled and the other a special model designed to bridge the progress from glider to airplane by introducing the take-off and landing attitudes of the plane, were used by 82 students with no injury to anyone in 1,219 lessons which averaged 30 min. each. There were nearly 7,000 glider flights.

When the student learns how to keep the wing level and steer directly in the rear of the tow-car, he is allowed to take the glider a foot or two off the ground, but with the stick tied forward so that there will be no risk of climbing too high or stalling.

A manila tow rope is used. It is fitted with rings at each end and about 40 ft. from each end, the rings close together being used for towing the glider back to the take-off point, where the tow-car disconnects from the inner ring and drives to the end opposite that to which the glider is attached, and makes fast to the ring at that end for the launching. Such an arrangement makes it possible for the instructor to man the tow-car alone and automatically stretches the rope in position when the glider is brought back for the take-off.

The value of gliding is apparent in the fact that low safe flights arouse as a rule, a deeper interest in learning to fly, that a number have learned to handle airplanes who probably would not have been able to learn to fly by the usual methods and that graduates of the glider school on the whole have completed their airplane training sooner and easier than the average student not having the background of fundamentals mastered through glider manipulation.

Eleven glider students advanced to airplane instruction. Six have private licenses, and two now own planes.

Fly customers to plant for sales

MASTER ELECTRIC COMPANY of Dayton has been using a Stinson Junior since early in the summer for transporting prospective and established customers to the factory for inspection of the plant as part of the sales program, for transportation of executives about the country and for occasional rushing of supplies and parts to various points. The plane has saved considerable time in transportation missions and has been effective in the sales promotion. Its chief use is in the novel plan of carrying individuals to the factory for inspection of the engineering methods, plant equipment and servicing methods.

SERVICING SHORT CUTS

Aviation

Portable cleaner in use

A portable cleaning outfit

FOR routine cleaning of engine and airplane parts the Atlanta shops of Eastern Air Transport, Inc., have built a very satisfactory spraying unit from a discarded hot water tank. The latter was cut down to convenient size and a new bottom welded in. It was then mounted on a pair of small wheels and a handle made of a section of steel tubing attached. A filling cap, air valve, and outlet connections were fitted in the top and a length of rubber hose with a simple spray gun attachment provided. A commercial form of mineral spirit, known as Varsol, is used with this outfit. The tank is partly filled with the solution and pressure applied by admitting compressed air at the top. A small gauge indicates the tank pressure.

Utility tools for the small shop

SMALL shops doing non-production or jobbing work must be equipped to handle a wide range of operations without tying up capital in specialized machinery which may be idle for a large percentage of the time. In the repair shops of Western Air Express it has been found that miscellaneous hole punching operations on sheet metal parts has been speeded up materially by the installation of a gang punch. The machine which they installed was supplied by the Meyer Machinery Company of Los Angeles. This punch is hand operated and mounts a series of dies for punching holes from ⅛ to 2 in. in diameter in sheet metal up to 16 gage in thickness. The operator has merely to select the proper punch and die size and to swing it in place over the work.

Fire prevention in the shop

AS IS often the case, the shops of the Atlantic Repair Depot of Eastern Air Transport, Inc. are some distance away from city fire-fighting apparatus, and it is necessary, therefore, to take every possible precaution to prevent the spreading of small fires. A generous supply of sand buckets, and 1-qt. hand type extinguishers is distributed about the walls of the hangar and shops. Extra precautions are taken in the refueling of airplanes at the gasoline pit on the apron, and in the storage of paint, dope, and other inflammable supplies.

While re-fueling the airplane structure is grounded to the gasoline pit by a steel chain and a clamp attached to one of the propellers. It is an invariable rule also, that during re-fueling a 1-gal. pressure-type Pyrene extinguisher must be placed within 6 ft. of the pit. This extinguisher is provided with a shoulder strap for carrying and it is the first duty of the mechanic in charge of refueling to see that it is in good working order before it is placed beside the airplane.

In the paint storage room, drums of dope and other inflammable liquids are stored on wooden racks, each set of which is provided with a copper bus bar, permanently connected to the ground. At each drum cradle a flexible copper lead is connected to the bus, and a heavy spring clip is provided for attachment to the edge of the metal drum. A metal plate on the floor, also connected to the bus, grounds the container into which the liquids are being tapped from the drums. This system keeps both container and drum at zero electrical potential, and eliminates the danger of fires starting by discharges of static electricity.

Aviation

Meyer gang punch in the shop of Western Air Express

Skiis for salvaging

AIRLINES operating over snow-covered mountainous territory, or swampy regions are sometimes faced with the necessity of salvaging an airplane which has been forced down in a location where removal by ordinary means is very difficult. For such purposes the Seattle shops of the United Airlines keep on hand a set of metal skiis consisting of two large and one small ski arranged for attachment to landing gear and tail skid respectively. Each is built up of flat sheet iron welded together and suitably braced. A case is on record where a plane was hauled for twenty miles through the mountains on the skiis after having been forced down by a snowstorm in a small canyon from which it was impossible to take off.

Aviation

Airplane salvaging skiis developed by United Airlines

THE BUYERS' LOG BOOK

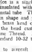
Oil immersion heaters

An oil immersion heater is being offered by the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa., for application to aircraft engine crankcases and oil storage tanks to keep the oil warm over-night or between runs, and thus save time normally required for warming up when starting. The device is a single heat unit encased and insulated with magnesium oxide in a metal tube. The tube is bent in a hairpin shape and permanently mounted in brass head casting. The threading of the head casting is 1-¼-18 National Fine Thread. Heater terminals with standard 10-32 threads are provided.

For application to aircraft engine crankcases it is necessary to drill and tap the case to install the heater. When desired to install the heater in aircraft oil storage tanks or for miscellaneous applications, an adaptor brass flange casting can be supplied which may be brazed to the tank or equipment on which it is to be mounted.—AVIATION, *January, 1932*

Vibration-proof tube coupling

The Dole Valve Company, of 1913 Carroll Ave., Chicago, has recently announced a new line of couplings and fittings for use with tubing of all materials, from ⅛ in. to ½ in. in diameter. The special feature of these fittings is a vibration-proof type of compression coupling which may be applied directly to the tube end without machining or soldering. The couplings are re-connectable without reduction in efficiency. Tests have indicated that they cannot be separated accidentally by vibration.—AVIATION, *January, 1932*



The Dole coupling

Aluminum solder

A new soldering material for aluminum and aluminum alloy has been marketed by the Allied Research Laboratories of Glendale, Cal., under the trade name of Alumaweld. The material may be applied with an ordinary soldering iron, or a blow torch, and its use has been reported in a number of instances where repair by welding had formerly been employed.—AVIATION, *January, 1932*

Stanley wrench set

Wrench set

A set of wrenches designed specifically for use on aircraft bracing wires has been introduced by the Stanley Works of New Britain, Conn. Both streamline and square wire wrenches are made to fit the sizes most commonly used. They are made of bronze so that they will not damage the wire, and are large enough to be easily handled but at the same time, not of sufficient length to give enough leverage to submit the wires to excessive strain. They are supplied in sets, or may be purchased individually.—AVIATION, *January, 1932*

Aluminum loudspeaker horn

A loudspeaker designed for outdoor use in connection with public address systems at airports, etc. has recently been offered by the Fox Engineering Company of Toledo, Ohio.

The horns are of conventional trumpet design, 6 ft. long, and with a bell diameter of 32 in. They are of spun aluminum, and are thus free from longitudinal seams or joints. The metal construction renders them free from the influence of moisture. Straight or curved units may be furnished. The weight of each is 12 lb.—AVIATION, *January, 1932*

Hangar heating units

A heating plant, designed especially for airplane hangars and other large buildings, has been marketed recently by the Illinois Stoker Company of Alton, Ill. The shop heater combines in one unit an automatic stoker, a heating unit, and the means for distributing heated air throughout the interior of the building. No piping or installation work is required other than the provision of a foundation for the unit and a stack connection to the outside air, although distribution pipes for hot air may be attached if desired. The overall dimensions of the unit are, 5 ft. wide, 60 ft. long, and 8 ft. high.—AVIATION, *January, 1932*

Safety carboy tilter

A new carboy tilter designed to prevent accidents while handling acids or other corrosive liquids, has been announced by the Schwenk Safety Device Corporation, of 27 Water St., New York City. Carboys are lifted into the tilter by a system of levers, which makes it unnecessary for the operator to lift them directly. The cradle in which the box rests provides support on three sides and the bottom, so there is no danger of the container dropping through the box though the wood be in bad condition. Full pouring control may be had at all times regardless of the amount of the liquid in the carboy.—AVIATION, *January, 1932*

Catalogs

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South Bend Lathe Works. A new catalog (No. 92) describing the full line of Series O Engine Lathes and Accessories, has been received from the South Bend Lathe Works of South Bend, Ind. All types of machines from 9-in. bench sizes up to 36-in. special purpose lathes are included.

Barnes-Gibson-Raymond, Inc. An elaborate catalog giving extensive data on the manufacture and use of springs of all types has been received from Barnes-Gibson-Raymond, Inc., of Ann Arbor and Detroit, Mich. Formulas and tables for the calculation of springs for all requirements are included.

DeVilbiss Company. A specialty catalogue giving complete descriptions and prices of spray-painting outfits for general use has recently been published by the DeVilbiss Company, Toledo, Ohio. This catalog not only lists the types of specialty equipment manufactured by this company, but gives detailed information as to its correct use and application. It is available on request.

American airplane specifications

Including only planes with approved type certificates—AVIATION does not assume responsibility for the figures given

PASSENGER PLANES WITH SEATS FOR FEWER THAN FOUR PERSONS

General / Power Plant:

Manufacturer	Designation	A.T.C. number	Price at factory	Type	Number of seats	Make of engine	Total rated hp	R.p.m. at rated hp	Fuel capacity (gal.)	Normal range
Aeromarine Klemm Corp	AKL-25-A	121	2,250	OML	2	Salmson	40	2,000	15	550
Aeromarine Klemm Corp	AKL-26-A	†204	2,500	OML	2	Lb	70	1,950	29	480
Aeromarine Klemm Corp	AKL-26-B	334	3,500	OML	2	Lb	85	2,125	29	465
Aeronautical Corp. of America	Aeronca Scout	351	1,245	OML	2	Aeronca	26.0	2,500	8	240
Aeronautical Corp. of America	Aeronca Collegian	396	1,695	OML	2	Aeronca	36.0	2,400	8	240
Alexander Industries Inc	Flyabout D-1	439	1,465	CML	2	Con	32	2,500	2	160
Alexander Industries Inc	Flyabout D-2	449	1,500	CML	2	Sz	45	1,750	7	150
Alexander Industries, Inc	Eaglerock A-13	141		OBL	3	Cu Ch	170	1,800	70	500
Alexander Industries, Inc	Eaglerock A-14	105		OBL	3	Wr Ww	165	2,000	70	500
Alexander Industries, Inc	Eaglerock A-15	108		OBL	3	K	100	1,810	47	470
American Airplane & Eng. Co	Pilgrim KR34C	152		OBL	3	Wr Ww	165	2,000	45	465
American Airplane & Eng. Co	Pilgrim KR34D	367		OBL	3	Co	165	1,900	45	435
American Airplane & Eng. Co	Pilgrim KR21	215		OBL	2	K	100	1,810	22	390
American Airplane & Eng. Co	Pilgrim KR21B	365		OBL	2	K	125	1,925	30	400
American Airplane & Eng. Co	Pilgrim 133	415		OBL	2	Rr	120	2,150	30	390
American Eagle Aircraft Co	Eaglet	380	1,475	OML	2	Sz	30	1,800	18	250
Arrow Aircraft & Motors Corp	A 2-60-L	115	2,350	OBL	2	Lb	60	1,950	16	200
Bird Aircraft Corp	Bird	419	4,895	OBL	3	Je	170	2,000	37	
Bird Aircraft Corp	Bird	982	4,250	OBL	3	W	110	1,850	37	600
Bird Aircraft Corp	Bird	987	5,820	OBL	3	Wr Ww	165	2,000	45	500
Bird Aircraft Corp	Bird	101	1,895	OBL	3	OX-5	90	1,400	45	430
Bird Aircraft Corp	Bird	239	2,995	OBL	3	K	100	1,080	35	685
Buhl Aircraft Co	Bull Pup	405	1,250	OML	1	Sz	45	1,250	10	260
Curtiss-Wright Airplane Co	CW A14D	442	8,250	OBL	3	Wr Ww	240	2,000	38	350
Curtiss-Wright Airplane Co	Robin C-1	†143		CML	3	Cu Ch	185	1,800	50	500
Curtiss-Wright Airplane Co	Robin J-1	†220		CML	3	Wr Ww	165	2,000	50	358
Curtiss-Wright Airplane Co	Moth	†197		OBL	2	Gy	90	1,950	35	540
Curtiss-Wright Airplane Co	CW-1Z	397	1,490	OML	2	Sz	45	1,825	[illegible]	200
Curtiss-Wright Airplane Co	CW-12Q	801	3,500	OBL	2	Wr Gy	90	1,950	33	484
Curtiss-Wright Airplane Co	CW-12K	406	4,266	OBL	2	K	125	1,925	33	400
Curtiss-Wright Airplane Co	CW-12W	407	4,455	OBL	2	War	110	1,850	33	410
Curtiss-Wright Airplane Co	CW-16K	411	4,468	OBL	3	K	125	1,925	33	400
Cycloplane Co. Ltd	C-1	445		OML	1	Cyclo	23	2,550	6	200
Davis Aircraft Corp	D-1-70	256	2,695	OML	2	Lb	65	1,950	20	350
Davis Aircraft Corp	D-1-K	272	2,995	OML	2	K	100	1,950	25	350
Davis Aircraft Corp	D-1-85	512	2,795	OML	2	Lb	85	2,125	20	350
Driggs Aircraft Corp	Skylark	303	2,775	OBL	2	Rover	75	1,975	22	801
Fairchild Aviation Corp	Fairchild 22	438	2,775	OML	2	Cir	95	2,100	21	315
Fleet Aircraft Inc	I	122		OBL	2	War	110	1,850	24	350
Fleet Aircraft Inc	II	†131		OBL	2	K	110	1,850	24	332
Franklin Aircraft Corp	90	430	3,350	OBL	2	Lam	90	2,375	25	450
Granville Bros. Aircraft, Inc	Gee Bee Model E	398	5,250	OML	1	War	110	1,850	38	550
Granville Bros. Aircraft, Inc	Gee Bee Model D	404	4,980	OML	1	Men	125	2,175	38	550
Great Lakes Aircraft Corp	2 T 1A	228	2,985	OBL	2	Cir	90	2,100	26	370
Great Lakes Aircraft Corp	2 T 1E	354	3,185	OBL	2	En	95	2,100	26	320
Inland Aviation Co	W 500	315	4,985	OML	2	War-7	110	1,975	31	500
E. M. Laird Airplane Co.	LC-R 300	126	11,500	OBL	3	Wr Ww	300	2,000	76	550
E. M. Laird Airplane Co.	LC-RJ 200	152	9,800	OBL	3	Wr Ww	220		26	800
E. M. Laird Airplane Co.	Whirlwind LC-B200	86	9,850	OBL	3	Wr Ww	220		26	800
E. M. Laird Airplane Co.	Whirlwind LC-B300	353	10,850	OBL	3	Ww	300		26	550
E. M. Laird Airplane Co.	Speedwing LC-RW	377	14,250	OBL	3	Pw	300		28	800
Mercury Aircraft Inc	Chic	235	1,750	OML	2	Lb	90	2,050	28	375
Mono Aircraft Corp	Monocoupe 90	306	3,375	CML	2	Lam	90	2,575	30	540
Mono Aircraft Corp	Monocoupe 110	527	4,250	CML	2	War-7	110	1,850	30	450
Nicholas-Beazley Airplane Co	NB-8G	452		OML	2	Co	80	2,310		
Rearwin Airplanes Inc	2000-CO	314	6,500	OBL	3	Con	165	2,000	55	500

Power Plant (cont.) / Weights / Performance:

Designation	Fuel consumption at cruising speed (gal per hr)	Diameter of propeller (in.)	Wing loading (lb per sq ft.)	Power loading (lb per hp)	Weight empty with cooling water if used	Payload (lb.)	Gross weight (lb.)	High speed (m.p.h.)	Cruising speed (m.p.h.)	R.p.m. at cruising speed	Stalling speed (m.p.h.)	Climb at sea level (f.p.m.)	Service ceiling (ft.)	Performance basis
AKL-25-A	2.7	86.5	6.8	33.1	815	239	1,325	74	60	1,750	40	400	8,500	Ma
AKL-26-A	4.75	86.5	8.2	22.7	1,025	206	1,590	93	78	1,650	42	600	12,000	Ma
AKL-26-B	5.5	86.5	8.2	18.7	1,016	215	1,590	97	85	1,800	42	700	14,000	Ma
Aeronca Scout	2.0	64	4.9	26.9	420	50	700	75	62	2,200	36	550	14,000	Ma
Aeronca Collegian	2.5	72	6.2	24.3	461	190	875	80	65	2,150	44	450	14,000	Ma
Flyabout D-1	3.0	58	5.5	26.8	573	170	962	80	70	2,000	28	350	8,500	Mo
Flyabout D-2	3.5	72	5.6	21.8	590	173	982	93	75	1,550	38	700	13,000	Mo
Eaglerock A-13	14.0	102	8.04	15.6	1,205	540	2,650	120	100	1,575	39	1,050	12,000	Ma
Eaglerock A-14	14.0	102	7.95	15.7	1,651	340	2,598	115	95	1,850	38	925	16,000	Ma
Eaglerock A-15	9.0	102	7.44	24.3	1,539	340	2,436	100	85	1,675	37	850	13,500	Ma
Pilgrim KR34C	9.2	102	8.32	14.35	1,524	380	2,368	121	97	1,700	46	635	13,500	Ma
Pilgrim KR34D	9.8	102	8.34	14.36	1,515	389	2,371	122	97	1,650	46	700	15,200	Mo
Pilgrim KR21	5.0	90	8.49	16.55	1,100	218	1,635	105	85	1,550	50	315	9,500	Ma
Pilgrim KR21B	7.0	96	8.98	13.83	1,120	232	1,730	112	97	1,600	52	800	15,200	Ma
Pilgrim 133	7.2	84	9.02	14.42	1,155	210	1,745	112	93	2,050	52	785	14,900	Ma
Eaglet														
A 2-60-L	6.0		7.35	19.5	900	170	1,346	100	83	1,800	40	900	14,000	Ma
Bird		99	8.8	18.66	1,350	540	2,303	132	111	1,900	35	1,200	20,000	Ma
Bird	6.0		8.6	18.36	1,230	370	2,020	112	98		34	950	16,500	
Bird	13.0		9.0	14.00	1,425	335	2,250	100	106		35	1,150	18,500	
Bird	8.0		8.1	23.9	1,500	370	2,150	110	98			200	15,000	Ma
Bird	6.0		7.5	19.8	1,250	370	1,890	110	90			800	16,000	Ma
Bull Pup	2.6		6.96	18.88	550		853	98	78	1,600		780	14,000	Ma
CW A14D	13.2	104	11.1	11.5	1,756	631	2,750	150	125	1,750	38	925	17,500	
Robin C-1	14.0		11.7	14.05	1,638	434	2,600	120	102	1,530	42	640	12,700	Ma
Robin J-1	12.5		11.28	15.3	1,625	390	2,325	118	100	1,700	45	750	13,200	Ma
Moth	7.0		6.78	16.3	1,043	200	1,650	105	90	1,670	40	700	15,200	Ma
CW-1Z	3.3	75	5.5	21.6	333	182	975	80	70		61	600	12,000	Mo
CW-12Q	4.6	84	8.4	19.1	1,071	268	1,725	103	88		47	600	12,500	Mo
CW-12K	7.5	96	8.6	14.3	1,164	246	1,800	112	98		31	800	11,500	Ma
CW-12W	3.5	94	8.6	16.2	1,106	226	1,800	112	98		31	750	15,000	Ma
CW-16K	7.5	96	9.5	15.6	1,176	383	1,950	115	95		54	850	12,500	Ma
C-1	2.4	62	3.5	29.1	450	190	670							
D-1-70	4.5	84	9.1	19.0	840	190	1,335	110	90	1,800	36	750	13,000	Ma
D-1-K	6.5	90	10.1	14.6	925	197	1,461	125	105	1,700	40	1,000	15,000	Ma
D-1-85	5.0	84	10.0	16.0	854	212	1,580	120	100	1,950	38	850	14,000	Ma
Skylark	5.0	84	7.4	18.4	878	501	1,529	105	85	1,400	45	650	14,000	Mo
Fairchild 22	6.3	84	8.8	13.7	918	267	1,500	114	94	1,750	47	650	13,000	Ma
I	6.0		8.1	14.57	1,055	211	1,580	108	90	1,650	46	700	15,200	Ma
II	6.0		8.06	14.52	1,023	218	1,575	108	90	1,650	46	730	15,200	Ma
90	3.3	84	8.1	16.6	885	335	1,500	126	100	2,100	40	1,100		Ma
Gee Bee Model E	7	84	14.0		912	50	1,400	155	128	1,750	35	1,400	20,000	Ma
Gee Bee Model D	7	84	14.0		922	50	1,400	159	130	1,900	35	1,500	21,000	Ma
2 T 1A	6.3	78	8.43	17.55	1,016	225	1,580	110	90	1,825	45	550	15,000	Ma
2 T 1E	6.3	78	8.43	16.63	1,016	215	1,580	116	90	1,825	45	550	15,000	Ma
W 500	7.0		10.2	13.5	910	195	1,490	135	100	1,850	48	1,000	16,000	Ma
LC-R 300			13.3	10.3	1,022	390	3,010	165	155		55	1,500	20,000	Ma
LC-RJ 200			14.4	13.2	1,848	390	2,914	150	120		55	1,200	18,000	Ma
Whirlwind LC-B200			9.6	13.0	1,800	390	2,850	135	110		45	1,200	19,000	Ma
Whirlwind LC-B300			10.3	10.1	1,830	390	3,020	150	120		45	1,600	22,000	Ma
Speedwing LC-RW			13.3	10.3	1,822	390	3,010	190	150		58	1,900	22,000	Ma
Chic	7.0		8.3	17.7	1,014	218	1,600	112	90	1,750	80	910	18,000	Ma
Monocoupe 90	5.2	78	11.5	16.9	868	262	1,519	118	100	2,000	45	930	15,000	Ma
Monocoupe 110	8.0	81	12.3	14.7	1,020	223	1,620	142	116	1,900	50	1,250	18,000	Ma
NB-8G			6.4	13.8	717		1,210	110	95		34	750	16,000	Ma
2000-CO	10.0				1,447	370	2,339							Ms

Continued on next page

Manufacturer	Designation	A.T.C. number	Price at factory	Type	Number of seats	Make of engine	Total rated h.p.	R.p.m. at rated h.p.	Fuel capacity (gals.)	Normal range	Fuel consumption at cruising speed	Diameter of propeller (ft.)	Wing loading (lb. per sq.ft.)	Power loading (lb. per h.p.)	Weight empty with cooling liquid if used	Payload (lb.)	Gross weight (lb.)	High speed (m.p.h.)	Cruising speed (m.p.h.)	R.p.m. at cruising speed	Stalling speed (m.p.h.)	Climb at sea level (f.p.m.)	Service ceiling (ft.)	Performance basis
GENERAL						**POWER PLANT**							**WEIGHTS**					**PERFORMANCE**						
Spartan Aircraft Co	C-3-225	286	7,750	OML	3	Wr Ww	240	2 000	60	495	13 0	104	9 29	12 9	1,740	390	2,780	135	110	1 750	50	1,160	13 900	Gt
Spartan Aircraft Co	C-2 60	427	2,145	OML	2	Jn	35	2,100	15	320	4 0	80	7 4	21 8	738	170	1,200	95	90	1 800	39	800	13 900	Ms
Star Aircraft Co	Cavalier C	255	2,985	CML	5	Lb	69	1,950	22	400			9 0	21 5	855	200	1,400	100	90		38	800	16 050	Ms
Star Aircraft Co	Cavalier E	321	3,310	OML	5	Lan	80	2,325	22	400	5 0	84	0 02	15 85	019	185	1,425			2 000	58	950	16 000	Me
Swallow Airplane Co	HW	325		OBL	2	Wr Ww	165	2,000	40	400	10 0		9 1	13 3	1 350	400	2,200	135	115	1 800	42	1,000	18 000	Ms
Swallow Airplane Co	HC	399		OBL	3	Con	165	2,000	40	400	9 0		9 1	13 3	1,558	400	2,200	150	110	1 800	42	1,000	18 000	Ms
Swallow Airplane Co	TP	105	2 975	OBL	2	OX-5	80	1,400	28	300	8 0		6 2	20 25	1 200	180	1 825	90	80	1 350	43	700	16 000	Ms
Swallow Airplane Co	TP h.	96		OBL	2	Jh	90	1 825	28	350	7 5		5 75	19 0	1,170	170	1,700	100	85	1 650	42	800	16,500	Ms
Swallow Airplane Co	TP-K	255		OBL	3	Wr	110	1,950	28	550	7 5		5 0	15 5	1,200	170	1,750	100	85	1 650	42	900	10 500	Ms
United-Eccles Airplane Co	Boeing 100	132	20,000	OBL	2	Pww	450	1,900	97	525	20 0		11 8	5 97	3,882	60	2,750	165	140	1,600	55			Ms
United-Stearman	C-3R	†251	8,500	OBL	3	Wr Ww	225	2,000	66	605	12 0		9 56	11 47	1,741	400	2,754	135	110	1 700	47	1,000	16 000	Ms
United-Stearman	4-E	292	16,000	OBL	4	Wr	420	2,000	100	620	21 0		12 62	9 37	2 426	624	3,956	158	130	1 700	55	1,400	18 000	Ms
United-Stearman	4-C	304	12,500	OBL	4	Wr Ww	500	2,000	100	825	15 0		12 38	12 62	2 256	663	3,900	145	118	1 700	55	1,000	15 000	Ms
United-Stearman	4-D	305	12,500	OBL	3	Twj	500	2,000	100	815	15 0		12 38	12 62	2 297	622	3,900	145	115	1 700	55	1,000	15 000	Ms
United-Stearman	6-A	365		OBL	3	Wr Ww	165	2,000	57	395	8 2		8 00	14 56	1,753	256	2,400	110	88	1 700	51	710	12 500	Gt
United-Stearman	6-F	371		OBL	3	Con	165	2,000	57	395	8 2		8 00	14 56	1,727	262	2,400	110	88	1 700	51	710	12 500	Ms
United-Stearman	6-D	432		DBL	2	Fwj	300	2,000	65	490	15 0	108	10 34	9 38	1,925	265	2,814	132	113	1 700	55	1,250	18 100	Gt
Verville Aircraft Co	Sport Trainer	525	5,250	OBL	2	Con	165	2,000	36	380	9 0		9 27	13 6	1,562			120	95	1 800	40	950	15 000	Ms
Vikins Flying Boat Co	Kittyhawk B-4	†166	4,220	OBL	3	Jk	110	1,815	35	500	6 5		8 05	18 8	1,107	362	1,675	110	95	1 650	38	1,200	15 000	Ms
Vikins Flying Boat Co	Kittyhawk B-8	†166	4,220	OBL	3	Jk	110	1,815	35	500	6 5	98	8 57	18 8	1,150	385	1,675	105	90	1 700	38	1,000	15 000	Ms
Waco Aircraft Co	HSO	352	7,500	OBL	3	Jdd	225	1,900	65	700	8 0		9 03	10 8	1,814		2,600	124	105			1 000	16,000	Ms
Waco Aircraft Co	QC	332	5,575	OML	3	Con	165	2,000	65	650	10 0		9 0	15 6	1,585		2,600	116	98			900	16 000	Ms
Waco Aircraft Co	INF	345	4,365	OML	3	Hisso-5	135	1,900	32	400	8 0		7 7		1,150		1,850	110	95	1 750		950	18 000	Ms
Waco Aircraft Co	PSO	339	5,175	OBL	3	Jw	140	1,800	85	625	9 0		8 5	12 4	1,508		2,641	106	85	1 750		900	12,000	Ms
Waco Aircraft Co	BSO	169	6,370	OBL	3	Wr Ww	165	2,000	65	625	10 0		9 03	15 75	1,528		2,600	120	100			700	16 000	Ms
Waco Aircraft Co	CSO	†240	7,225	OBL	3	Wr Ww	240	2,000	65	660	12 0		9 03	11 5	1,620		2,600	128	105			1,200	19 000	Ms
Waco Aircraft Co	CTO	†252	8,525	OBL	3	Wr Ww	240	2,000	65	650	12 0		11 45	11 5	1,622		2,600	138	115	1 750	48	1,500	19 000	Ms
Waco Aircraft Co	RNF	†311	4,250	OBL	3	Wasp	110	1,850	32	400	8 0		7 8	17 2	1,110		1,900							Ms
Waco Aircraft Co	RNF	313	4,100	OML	3	K	100	1,810	32	385	7 0		7 8	17 2	1,095		1,900							Ms
Waco Aircraft Co	QCF	416	4,995	OML	3	Con	165	2,000	40		8 0		9 0	13 51	1,285	428	2,200	124	108	1 850	42	1,050	16 000	Ms
Waco Aircraft Co	INF	395	4 672		3	Mon	125	2,175	32				7 0	15 2	1,135	360	1,800	115	95	2,000	50	600	14 000	Ms

CARGO PLANES WITH SEATS FOR FEWER THAN FOUR PERSONS

Curtiss Aeroplane & Motor Co	Carrier Pigeon	252		OBL	1	Cu Cq	600	2,400	175	700	32 0		13 82	11 96	4 255	2,005	7 600	130	128	2,100	60	780	14 200	Ms
Detroit-Lockheed Aircraft Co	Sirius A	500		OML	2	Pww	420	2,000	130	980	21 5		16 7	10 95	2,078	Var	4 600	173	140	1 700	60	1 200	20 000	Gt
Detroit-Lockheed Aircraft Co	Sirius DL-2	578		OML	2	Pww	420	2,000	140	940	21 3		16 9	12 50	2,958	1 106	5 170	175	143	1 700	61	1 100	18 000	Ct
Fleasen Aircraft, Inc	FA-5, Mayling	500	12,500	OBL	2	Ww	500	2,000	80			105	14 4	13 5	2,294	1 020	4 000							Ms
United-Stearman Aircraft Co	4-EM Speedmail	322	16,000	OBL	1	Pww	420	2,000	106	645	21 0		12 82	9 57	2 455	600	3,956	158	130	1 700	55	1,400	18 000	Ms
United-Stearman Aircraft Co	4-DM Speedmail	325	12,500	OBL	1	Ww	300	2,000	106	855	13 0		12 82	13 12	2 285	770	3,956	145	118	1 700	55	1,000	15 000	Ms
United-Stearman Aircraft Co	4-DM Speedmail	326	12,500	OBL	1	Fwj	300	2,000	106	815	15 0		12 82	13 12	2 326	720	3,956	145	115	1 700	55	1,000	15 000	Ms

SINGLE-ENGINED PLANES WITH SEATS FOR MORE THAN THREE PERSONS

American Airp. & Eng. Corp	Pilgrim 100	300		CML	3	Pwh	575	1,950	120	450	34 0	124	15 6	11 3	3,700	1 820	6,500	142	122	1,750	63 0	900	18,000	Ms
American Airp. & Eng. Corp	Pilgrim 71	89		CML	2	Pww	420	2,000	148	748	21 0	108	17 7	13 1	2,940	1 422	5 500	125	106	1 700	65 8	700	14 150	Ms
American Airp. & Eng. Corp	Pilgrim 42	242		CML	4	Wr Ww	300	2,000	105	515	18 0	108	15 6	14 1	2,628	210	4 246	120	103	1 700	50 0	500	12 100	Ms
American Airp. & Eng. Corp	Pilgrim 51	245		CML	4	Wr Ww	300	2,000	63	515	18 0	108	15 7	14 7	2,356	194	4,000	120	100	1 700	57 0	730	15 500	Ms
American Airp. & Eng. Corp	Pilgrim 100A	445		CML	10	Pwh WrCy	575	1,950	120	380	37 0		16 0	13 5	4 630	2,160	7 250	126	118	1 750	65 0	750	12,600	Ms
Bellanca Aircraft Corp	Pacemaker	†129	15,150	CML	6	Ww	300	2,000	112	850	16 0	108			2,363	1 050	4 300	150	125			900	17 000	Ms
Bellanca Aircraft Corp	Pacemaker	†328	15,550	CML	6	Pwj	500	2,000	112	850	16 0	108			2,465	952	4 200	150	125	1,800		900	17 000	Ms
Bellanca Aircraft Corp	Pirate	249	15,150	CML	6	Ww	500	2,000	80	850	16 0	108			2,200	1 500	4 000	150	124	1 800		750	17 000	Ms
Bellanca Aircraft Corp	Skyrocket	†519	17,950	CML	6	Pww	420	2,000	120	750	21 0	110			2,502	1 058	4 600	155	130	1 700		1,250	20 000	Ms
Bellanca Aircraft Corp	Airbus	560	58,500	CML	12	Cu Cq	600	2,450	200	250	32 0	147	14 2	15 8	5 400	2 522	9 500	147	126	2,150		750	16,400	Ms
Bellanca Aircraft Corp	Airbus	561		CML	12	Wr Cy	575	1,800	200	250	31 0	118	14 3	16 7	5 220	2 980	9 500	138	120			750	13,200	Ms
Bird Aircraft Corp	Bird	†588	4,395	OBL	1	Jk	125	1,625	32	530	7 0		8 8	10 68	1,350	540	2,503	120	100		35 0	1,100	12,000	Ms
Consolidated Aircraft Co	Fleetster 17	291		CML	8	Pwh	575	1,950	150	500	20 0		17 9	9 8	5 326	1 414	5 000	175	150	1,700	65 0	1,200	16 000	Ms
Consolidated Aircraft Co	Fleetster 17 20	369		CML	8	Wr Cy	575	1,950	146	500	32 0		17 8	9 8	5 443	1 325	5 600	180	153	1 950	64 0	1,050	19 600	Gt
Consolidated Aircraft Co	Fleetster 20	520		CML	8	Pwh	575	1,950	130	700	32 0		17 8	10 5	5 400	1 600	7 000	165	140	1,700	65 0	1,200	17,500	Ms
Curtiss-Wright Airplane Co	CW-15C	426	4,595	CML	4	Cu Ch	185	2,000	60	625	9 4	102	11 4	16 9	1 975	503	3 125	115	98		54 0	625	14 000	Ms
Curtiss-Wright Airplane Co	CW 15N	425	5,100	CML	4	K 4	210	1,900	60	530	12 0	102	13 5	13 2	1,965	667	3,200	125	106		58 0	700	15 000	Ms
Curtiss-Wright Airplane Co	CW-15D	424	9,600	CML	4	Wr Ww	300	2,000	60	500	12 5	108	13 5	13 5	2,005	622	3,200	135	115		58 0	750	16 000	Ms
Curtiss-Wright Airplane Co	CW-A5A	436		CML	4	Pww	420	2,000	130	725	20 5		14 6	13 5	5 332	1 256	5 600	138	114	1,700	65 0	850	18,000	Ms
Curtiss-Wright Airplane Co	4-C-1 A	509	7,995	CML	4	Cu Ch	185	1,800	56	461	10 1	66	12 8	13 6	1,811	551	2,050	115	98	1,550	38 0	505	11,200	Ms
Curtiss-Wright Airplane Co	5-B	555		CML	6	Ww	300	2,000	80	560	18 0	108	15 9	13 0	2,739	850	4,452	144	115	1,800	66 0	900	16,300	Ms
Detroit-Lockheed Aircraft Corp	Vega Model 5B	2227		CML	6	Pww	420	2,000	100	700	21 5	108	14 8	10 4	3,995		5,500	180	150	2,200	60 0	1,275	19,800	Ms
Detroit-Lockheed Aircraft Corp	Vega DL-1	508		CML	6	Pww	420	2,000	100	700	21 5	108	16 4	10 7	2,595	Var	4,500	178	150	1,200	58 0	1,345	18,750	Gt
Detroit-Lockheed Aircraft Corp	Air Express	102		CML	5	Pww	420	2,000	100	675	21 5	108	14 8	10 4	2,533	1,012	4,375	175	142	1,700	58 0	1,200	20,000	Ms
Detroit-Lockheed Aircraft Corp	Orion	421		CML	7	Pww	450	2,100	125	900	29 0	108	18 7	11 5	5 250	Var	5 200	215	180	1,900	64 0	1,450	21,600	Ms

Northrop Aircraft Corp	Alpha	†301	21,500	CML	7	Pww	420	2,000	85	700	21 0	113	15 5	10 7	2,626	1,022	4,500	120	140	1,800	60 0	1,400	10,300	Ms
Spartan Aircraft Co	C4-225	310	9,250	CML	4	Ww	240	2,000	85	615	15 0	104	11 74	14 7	2,325	Var	3,815	136	109	1,800	51 0	805	15,000	Ms
Spartan Aircraft Co	C4-300	303	11,700	CML	4	Ww	300	2,000	85	631	16 0	104	13 2	13 2	2,567	660	5,065	143	122	1,800	56 3	900	15,400	Ms
Spartan Aircraft Co	C4-301	594	11,900	CML	4	Pwj	300	2,000	85	631	16 0	104	13 2	13 2	2,597	513	5,065	145	124	1,800	56 3	965	15,200	Ms
Spartan Aircraft Co	C5 301	389	12,900	CML	5	Pwj	300	2,000	65	820	16 3	104	13 9	13 9	2,607	830	4,175	145	124	1,800	52 5	960	14,600	Ms
Stinson Aircraft Corp	W-3r	435	8,995	CML	4	Pwj	300	2,000	73	425	16 0		12 5	12 2	2,270	610	3,650	143	122	1,800	55 0	850	18,500	Ms
Stinson Aircraft Corp	S-1r	424	4,995	CML	3	Jr	215	1,900	55	450	12 0	102	13 5	13 2	1,990	660	3,265	125	105	1,800	52 0	650	15,000	Ms
United Boeing Airplane Co	40-B-4	183	22,500	CBL	4	Pwh	525	1,900	140	450	25 0		11 2	11 6	3,400	1,171	6,000	130	110	1,600	54 0	750	15,000	Ms
United Boeing Airplane Co	221	566		CML	7	Pwh	575	1,950	135	500	34 0		15 0	13 9	4 990	1,020	8,000	158	137	1,700		850	14,000	Ms
United-Stearman Aircraft Co	LT-1	187	25,000	CBL	5	Wh	525	2,000	45	610	26 2		12 8	11 9	5,990	1 215	6,259	140	110	1,700	50 0	900	15,000	Ms
Waco Aircraft Co	QDC	412	5,985	CBL	4	Con	165	2,000	40				10 6	15 7	1,512	658	2,600	116	105	1,850	48 0	700	14,000	Ms

MULTI-ENGINED PLANES WITH SEATS FOR MORE THAN THREE PERSONS

Curtiss Aeroplane & Motor Co	Condor	193		CBL	21	2 Cu Cq	1,200	2,450	278	910	65 0		11 8	14 0	11,674	3 800	12,800	145	125	2,150	3 50	870	12,000	Ms
Curtiss-Wright Airplane Co	Kingbird D-1	547	23,295	CML	8	2Ww	480	2,000	130	454	25 4	104	15 1	12 73	3,754	1 230	6,115	130	112 5	1,700	62 0	820	14,700	Ms
Curtiss-Wright Airplane Co	Kingbird D-2	568	25,555	CML	8	2Ww	690	2,050	130	415	36 0	106	15 1	10 20	3,727	1 220	6,115	142	120	1,700	65 0	1,000	18,000	Ms
Curtiss-Keystone Aircraft Corp	Patrician	20		CML	20	3 Wr	1,575	1,800	535	720	80 0	132	16 50	16 200	8,560	1,650	16,000	130	110		50 0	1,000	15,000	Ms
Ford Motor Co	4-AT-F	441		CML	14	3 WrWw	900	2,000	231	580	45 0		14 0	12 2	6,200	2,358	11,000	130	113	1,700	50 0	960	16,200	Ms
Ford Motor Co	5-AT-D	409		CML	16	3 Pww	1,260	2,000	272	550	60 0	120	16 8	11 2	8,140	3 610	14,000	150	120	1,700	65 0	975	12,500	Ms
Ogilvie Aeronautical Corp	Osprey C	322	16,000	CML	3	Cr	220	2,000	90	500	18 0	78	10 6	16 20	3,350	940	4,500	130	105	1,850	65 0	650	15,000	Ms
Stinson Aircraft Corp	S-6M	355	25,900	CML	11	Ly	645	2,000	120		34 5		17 5	13 5	5,475	2,022	9,000							

AMPHIBIONS AND FLYING BOATS

American Aeronautical Corp	S-56	287	5,500	OBA	2	K	90	1,860	28	250	7 0		7 5	21 5	1,447	365	2,150	86	75	1,700	42 0	400	6,500	Ms
American Aeronautical Corp	S-51	336	6,200	OBA	3	K	125	1,900	28	300	7 0		7 7	17 7	1,462	388	2,218	101	85	1,800	34 0	700	10,500	Ms
Amphibions, Inc	Ireland N-2B	153		OBA	3	Ww	300	2,000	60	450	18 0	108	13 0	11 5	3,200	800	5,000	105	85	1,700	48 0	500		Ms
Amphibions, Inc	Ireland N-2C	248		OBA	5	Pww	420	2,000	60	450	18 0	108	13 0	11 5	5,240	900	4,000	120	95	1,700	48 0	900		Ms
Amphibions, Inc	Privateer	570	5,000	OMA	2	War	110	1,850	50	280	8 0	97	10 5	10 0		210	2,100	65	75	1,820	41 0	550		Ms
Consolidated Aircraft Co	Commodore	258		CMF	25	2 Pwh	1,150	1,950	650	1,000	60 0		15 8	15 3	10,410	3,200	17,500	128	104	1,700		600	10,000	Ms
C. W. Keystone Aircraft Co	Air Yacht	90		CBA	5	Cy, Pwh	525	1,900	140	1,221	20 0	106	12 1	11 4	3,915	1,150	6,200	150	55 0			850	13,500	Ms
C. W. Keystone Aircraft Co	Commuter	219		CBA	4	Ww	900	2,000	70	400	15 0	108	9 5	13 8	2,950	640	4,150	112	97		50 0	850	12,000	Ms
Douglas Aircraft Co	Dolphin	422	35,000	CMA	8	2 WrWw	800	2,000	180	720	30 0	108	14 6	13 7	5,625	15 00	8,200	146	120	1,700	60 0	625	16,200	Ms
United Boeing Airplane Co	204	327	13,000	OBF	5	2 Pww	450	1,900	80	350	20 0		10 6	12 2	3,350	913	5,000	133	110	1,625	50 0	625		Ms
United Sikorsky Aviation Corp	S-38	126		CQA	10	2 Pww	840	2,000	330				14 3				10,420	128	110	1,650	55 0	750	18,000	Ms
United Sikorsky Aviation Corp	S-38	356		CQA	10	Pwh	1,150	1,950	330				14 3				10,420							
United Sikorsky Aviation Corp	S-39	325		CMA	5	Pwj	300	2,000	65	350	17 0		11 4	13 5	2,678		4,000	120	100	1,750	54 0	750	16,000	Ms
United Sikorsky Aviation Corp	S-40	454		CMA	38	4 Pwh	2,300	2,000	1,066	800	140 0		18 3	14 8	23,000	Var	36,000	135	112	1,750	64 0	700	15,000	Ms
United Sikorsky Av at on Corp	S-41	418		CMA	13	2 Pwh	1,150	2,000	520		60 0		17 3	11 1	9,072	Var	12,800	131	115	1,750	60 0	825	18,200	Ms
Viking Flying Boat Co	V-2	361	12,000	OBF	4	Ww	240	2,000	80	400	12 0		8 6	14 4	2,300	582	5,450	105	90	1,250	46 0	750	14,000	Ms

A —Amphibion	Br —Brownback	Cu —Curtiss	Gt —Guv't test	L —Laudylane	Na —Navigation	Pwj —P & W Wasp Jr.	Sh —Sheet	W —Wood
Aep —Aircraft Products	Bx —Beadix	Cv —Conventional	Gy —Gipsy	Le-I —Ace	O —Open	Pww —P & W Wasp	Sk —Stick	Wa —Walter
Ad —Aldal	C —Cessna	Cy —Cleland	H —Hamilton	Lam —Lambert	Ol —Oleo	Q —Sesquiplane	Sol —Solid	War —Warner
Aer —Aeral	Ca —Cable	D —Duralumin	He —Henderson	Lb —LeBlond	Old —Oildraulic	R —Rubber	Sp —Spruce	Wet —Werner Tress
Al —Axle	Can —Cantilever	Don —Doperdasain	His —Hispano	Li —Liberty	Op —Optional	Ret —Retractable	Spl —Split	We —Westinghouse
Amer—American	Cd —Cord	Du —Dual	Hr —Heat treated	Lk —Lockheed	OX-5—Curtiss	Ro —Reuted	St —Standard	Wh —Wheel
Apl —Applied	Cg —Corrugated	En —Enskin	Hw —Ross Warrior	Lmd —Laminated	P —Paragon	Rr —Ranger	Str —Straight	Wi —Wire
Aw —Air Wheels	Ch —Challenger	Ex —Extra	Hyd —Hydraulic	Lr —LeRhone	Pa —Pedal	Rus —Russo	Su —Supreme	Wl —Welded
Ax —Axelson	Cir —Curtiss	F —Flying boat	I —Ignition	Ly —Lycoming	PM —Packard Diesel	Rv —Riveted	Sy —Story	Wr —Wright
B —Biplane	Co —Comet	Fab —Fabric	In —Internal	M —Menasco	Pk —P-K screws	S —Steel	Sz —Szekely	Wi —Wind Tunnel
Bal —Balsilla	Com —Compression	G —Gland	Ir —Irwin	Me —Metal	Ply —Plywood	Sa —Sausedle	T —Tubing	Ww —New Whirlwind
Be —Buson	Con —Continental	Ge —Genet	Ja —Jacobs	Men —Menasco	Po —Pneumatic	Sc —Shock Cord	Tr —Trombone	Y —Yankee
Bo —Bolted	Cq —Conqueror	Go —Goodyear	K —Kinner	Mo —Monocoque	Pr —Push Rod	Scd —Screwed	Tred —Treadle	Z —Seaplane
Box —Box spar	Cs —Casled Springs	Gr —Gruss	Kn —Kaiser-Hayes	Ms —Mfr's statement	Pwh —P & W Bernat	Sd —Stamped	Trs —Truss	# —Without engine

†Amaroved also as float type seaplanes

American airplane specifications (continued)

Including only planes with approved type certificates—AVIATION does not assume responsibility for the figures given

Manufacturer and Designation	A.T.C. Numbers	General: Span	General: Length overall	General: Height overall	Areas (sq ft): Wing	Areas: Aileron	Areas: Fin	Areas: Rudder	Areas: Stabilizer	Areas: Elevators	Wings: Spars: Material	Wings: Spars: How fabricated	Wings: Ribs: Material	Wings: Ribs: How fabricated	Wings: Covering material	Landing Gear: Type	Landing Gear: Tread (in.)	Landing Gear: Wheel type and size	Landing Gear: Brakes	Landing Gear: Shock unit (landing gear and tail)	Landing Gear: Tail wheel	Fuselage or Hull: Framework: Material	Fuselage or Hull: Framework: How fabricated	Fuselage or Hull: Covering material	Fuselage or Hull: Volume of baggage compartment (cubic ft.)
PASSENGER PLANES WITH SEATS FOR FEWER THAN FOUR PERSONS																									
Aeromarine Klemm	121 204 334	40 2"	24' 0"	7' 0"	194	5	18	5	5.0	6	5	17	2	14	0	W	Box	W	Ply	Ply	Spl	85	Aw20x 9	Na	Old R	No	W			PlyFab	6 0
Aeronautical Corp. Aeronca	331 396	30 0	20' 5"	7' 0"	192	2	7	9	5.6	16.0	7	1	0.3	Sp	Sel	Sp	G	Fab	Spl	60	Gn18x 8	Na	Sp	No	ST	Wi			Fab	3 0
Alexander Eaglerock	343 8 25-11 190	34' 8"	25-11"	9'10"	287	42	6	4	2.10	2	23	9	10	8	W	I	W	Trs	Fab	Spl	72	Kh30x 5	Kh	Sa	No	ST	Wi			Fab	4 0
Alexander Flyabout	436 449	37' 9"	25' 0"	6' 5"	255	20	6	5	2	4	18	8	13	0	Sp	Sel	Sp	Trs	Fab	Spl	54	Gn 16x2-8	No	Na	No	ST	Wi			Fab	6 5
Amer Arp & Enc. Pilgrim KR-21	215 308	22 6"	21' 1"	8' 6"	125	7	16	9	4.4	5	5	12	9	8	6	Sp	Sel	Sp	G	Fab	Spl	61	Kh24x 4	Yes	Ol Spr	No	ST	Wi			Fab	2 75
Amer Arp & Enc. Pilgrim KR-54	102, 370	30' 0"	23' 2"	8' 9"	248	36	4	4	3	5	27	4	16	9	Sp	Sel	Sp	G	Fab	Spl	65	8x 25x 4	Be	Ol Spr	No	ST	Wi			Fab	8 25
Amer Arp. & Eng. KR 135	413	22' 0"	21' 1"	8' 6"	125	7	10	9	4.4	5	5	12	9	9	6	Sp	Sel	Sp	G	Fab	Spl	81	Kh24x 4	Be	Ol Spr	No	ST	Wi			Fab	1 16
American Sackle Eaglet	380	34' 4"	21' 6"	6 10"																					
Arrow Aircraft	115	25' 10"	19' 3"	7' 5"	183	8	25	2	2' 3"	8	13	0	10	4	W	O	W	G	Fab	Spl	28	Wi 26x 4		Ca	No	ST	Wi	Fab		3 0
Bird Aircraft Corp	101 239 382 387 419	34' 0"	23' 5"	8' 0"	208	12	2	5	8	7	5	19	9	13	6	W	Sel	W	Trs	Fab	Spl	60	Ver	Var	Ol Spr	Na	ST	Wi	Fab		15 0
Buhl "Bull Pup"	405	20' 0"	15' 6"	6' 6"	109	4	6	2	1' 6"	3	10	4	5	0	Sp	Sel	W	Sp	Fab	Spl	62	Gt	18	3						Fab		D	3 5
Curtiss-Wright Robin	143 220	41' 0"	23' 10"	8' 5"	224	22	3	5	4	9	2	25	2	8	6	W	G	Ad	Sel	Fab	Spl	96	Bx 28x 4	Bx	Ol	Na	ST	Wi	Fab		12 5
Curtiss-Wright Moth	197	30' 0"	24' 11"	8' 8"	215	22	2	2	2	9	3	13	3	12	9	Sp	Sel	G	Ad	Sel	Fab	Spl	60	24x 4	K		No	ST	Wi	Fab		2 0
Curtiss-Wright Sport Trainer	401, 408, 407, 411	28' 10"	20' 2"	8' 10"	206	17	8	5	5	6	15	4	12	7	Sp	Sel	Sp	Trs	Fab	Spl	73	Aw 05x 10	St	Hyd		St	ST	Wi	Fab		2 0
Curtiss-Wright Junior	597	30' 6"	21' 3"	7' 4"	176	10	5	1	8	5	15	5	14	7	Sp	Sel	Sp	Trs	Fab	Tank	53	Aw 16x 7	Op	S Spr	Op	ST	Wi	Fab			
Curtiss-Wright Sportsman	442	31' 0"	23' 6"	9' 2"	248	21	5	5	4	10	4	19	1	11	9	Sp	Sel	Sp	Trs	Fab	Spl	81	8 5x 16	Air	Hyd	Yes	ST	Wi	Fab		
Cyclaplane	445	30' 9"	19' 3"	7' 6"	163	50	0	5	3	9	7	15	9	14	7	Sp	Sel	W	Trs	Fab	Spl	62	Go Aw	Na	Spr Sa	Yes	ST	Wi	Fab		
Davis D-1	2256, 272, 317	33' 5"	21' 6"	7' 0"	202											W	Sel	G	Fab	Spl		76	Kh	Spr			ST	Wi	Fab		38 5
Driggs Skylark	303	28' 5"	21' 6"	8' 0"	186	19	4	5	9	7	5	13	8	10	9	Sp	Sel	O	Sel	Fab	Spl	72	W16.50x10	Yes	Old R	No	ST	Wi	Fab		
Fairchild 22	438	32' 10"	21' 8"	8' 0"	126	29	0	4	1	8	0	15	8	10	4	Sp	I	Sp	Fab	Spl	91	6.50x10	Ab	Ol	Op	ST	Wi	Fab		
Fleet	122 131	28' 0"	21' 0"	7' 10"	182	11	8	1	0	8	1	13	5	4	8	Sp	Lmd	D	Ry	Fab	Spl	64	Wi 26x 5	Op	Ol	No	ST	Wi	Fab		
Franklin 99	430	28' 0"	19' 0"	7' 6"	107	16	0	5	5	5	6	12	2	11	1	W	Ply	G	Fly	Fab	Spl	60	Go Aw	Ap	Ol	Yes	ST	Wi	Fab		
Granville Bee Gee E D	398 404	25' 5"	17' 3"	5' 0"	97	7	10	3	4	8	0	10	6	8	8	Sp	Sel	Ply	O	Fab	Wb	79	Go 6.50x10	Ap	Ol Spr		ST	Wi	Fab		2 0
Great Lakes 2 T	228	26' 0"	20' 4"	7' 11"	121	16	6	3	5	5	2	13	5	9	5	Sp	I	D	Sel	Fab	Spl	70	Wi 24x4	Bx	Ol	No	ST	Wi	Fab		
Inland Sport	315	30' 0"	13' 11"	7' 2"	134	12	5	3	1' 8"	6	1	13	0	8	9	Sp	Ro	Sp	Trs	Fab	Spl	96	Acp	Op	Old		ST	Wi	Fab		6 0
Laird LC-R	176	34' 0"	23' 9"	9' 3"	202				13' 0"			20	0			W	Sel	G	Fab	Spl			Sa		R, Cd	Na	DT		Fab		
Laird LC-RJ	152	28' 0"	22' 9"	9' 3"	202				13' 0"			26	0			W	Sel	G	Fab	Spl			Bx		R, Cd	No	DT		Fab		
Laird Whirlwind LC-B	553, 80	34' 0"	23' 9"	9' 3"	202					13.0				56	0	Sp	Sel	Sp	Ply	G	Fab	Spl		Bx 30x 5	Yes	Sa	Na	DT		Fab		40 5
Laird Speedwing	323	28' 0"	22' 7"	9' 0"	202					13.0				23	0	Sp	Sel	Sp	Ply	G	Fab	Spl		Bx 30x 5	Yes	Sa	Na	DT		Fab		38 5
Mercury Chic	233	35' 8"	25' 0"	8' 7"	192	34	8	0	9	5	0			18	6	ST	Wi	ST	Wi	Fab	Spl	72 5		28x	4	Na	Sa R	Na	ST	W	Fab		
Meno Corp. Monocoupe	327 506	32' 0"	20' 4"	6' 11"	152	3	15	5	4	1	5	8	10	6	9	Sp	I	Sp	G	Fab	Spl	65	Ap 6 5x10	Acp	Old		Na	ST	Wi	Fab		4 5
Nicholas-Beazley NB-8G	452	32' 0"	20' 3"	7' 9"												W	W			Fab	Spl		Co Aw	Na	Ol		Na	ST	Wi	Fab		
Rearwin 2000	314	35' 0"	25' 0"	9' 11"																			Bx 28x 4	Bx	R, Ol							
Sioux Coupe 90	331	30' 0"	23' 2"	7' 0"	163											Sp	Sp	C	Fab	Spl		72	Aw		Yes		No	ST	Wi	Fab		9 0
Spartan C2-60	427	40' 0"	23' 5"	6' 11"	192	22	8	6	8	10	2	14	8	19	6	Sp	Sel	Sp	Ply	Trs	Fab	Spl		96	Go Aw		Na	No	No	ST	Wi	Fab			25
Spartan C-3	286	32' 5"	23' 0"	8' 9"	192	22	8	6	8	10	2	14	8	19	6	Sp	Sel	Sp	Ply	G	Trs	Fab	Spl		85	Kh 30x 5		Bx	Old	Op	ST	Wi	Fab		5 6
Star Cavalier	255 321	31' 6"	19' 11"	6' 8"	159	12	9	4	5	5	14	9	9	9	5	Sp	Ro	I	Sp	Fab	Spl		61	Aw 22x 10		Ca			ST	Wi	Fab			
Swallow TP	105, 186, 253.	30' 11"	23' 9"	8' 10"	268	28	0	5	0	7	8	14	0	10	5	W	G	W	G	Fab	Str	Al	72	26x 4		Sa			ST	Wi	Fab			
United Boeing 100	153	36' 0"	20' 8"	9' 2"	226	13	0	1	8	8	2	19	9	13	4	Sp	Ro	Sp	G	Fab	Str		75	Bx 30x 5		Bx	Ol	Na	8 15	Wi	Rv	D	Fab	4 0
United Aircraft-Stearman C	251	35' 0"	25' 0"	9' 2"	288	22	0	5	6	8	2	19	6	14	0	Sp	Sel	Sp	Trs	Fab	Spl		84	8x 50x10		Bx	Ol R	No	ST	Wi	Fab			16 0
United Aircraft-Stearman 4	292, 304 303	34' 0"	26' 1"	10' 2"	307	23	1	6	8	12	5	27	7	15	0	Sp	Sel	Sp	Trs	Fab	Spl		96	Bx 30x 5		Bx	Aer	Yes	ST	Wi	Fab			16 0
United Aircraft-Stearman 6	365 371	32' 8"	24' 5"	9' 6"	272	26	6	4	7	9	1	19	1	14	3	Sp	Sel	Sp	Trs	Fab	Spl		85	Bx 30x 5		Bx	Aer	Yes	ST	Wi	Fab			3 5
Verville Sport Trainer	523	28' 0"	20' 0"	7' 0"	178	20	0	3	5	9	5	18	0	13	5	Sp	Sel	W	G	Fab	Spl		96			Bx	Old	Yes	ST	Wi	Fab			5 0
Viking Kittyhawk	166 392	24' 0"	22' 0"	8' 8"	233	22	3	7	0	4	24	5	12	5	0	Sp	Ro	W	G	Fab	Spl		85	Kh 24x 4		Op	Ol	No	ST	Wi	Fab			3 0
Waco F	511, 513 345 416	29' 6"	21' 4"	8' 9"	241	22	0	4	5	7	0	12	0	15	5	Sp	Sel	Sp	Ply	G	Fab	Spl		76	6 5x10		Acp	Ol	Yes	ST	Wi	Fab			
Waco Taperwing	252	30' 5"	22' 7"	9' 9"	227				4' 7"	7	8	10	1	14	7	W	Sel	W	Trs	Fab	Spl		78	30x	3	Bx	Hyd		ST	Wi	Fab		
Waco Straightwing	168 240 533 337 539	35' 7"	23' 1"	9' 0"	289	29	7	4	8	7	8	19	5	10	5	Sp	Sel	Sp	Ply	G	Fab	Spl		78	30x	3	Bx	Ol	No	ST	Wi	Fab			
CARGO PLANES WITH SEATS FOR FEWER THAN FOUR PERSONS																									
Curtiss-Wright Carrier Pigeon	257	47' 0"	34' 6"	13' 5"	350	70	4	10	9	25	5	41	9	41	5	Sp	Box	Sp	G	Fab	Spl		99	Bx 40x10		Yes	Ol		D	Rv	MaMe			
Detroit-Lockheed Sirius	500 528	42' 10"	27' 6"	9' 2"	250	25	0	11	5	13	0	30	0	23	5	Sp	Box	Sp	G	Fly	Spl		144	Bx 52x 6		Bx	Ol	No	W	Mo	Ply		50 0	
Pitcairn Mailwing	504	35' 0"	24' 9"	10' 2"	251	26	5	8	3	7	9	18	5	10	3	Sp	Box	Sp	Ply	G	Fab	Spl		96	Bx 30x 6		Bx	Ol		ST	Wi	Fab		60 0	
United-Stearman Speedmail	322 325 326	38' 0"	30' 11"	10' 2"	284	23	1	6	8	11	2	27	2	16	8	Sp	Sel	Sp	Trs	Fab	Spl		96	Bx 30x 5		Bx	Aer	Yes	ST	Wi	Fab		45 0	
SINGLE ENGINED PLANES WITH SEATS FOR MORE THAN THREE PERSONS																									
American A & E Co. Pilgrim 100A	443	57' 8"	38' 0"		415	48	0	12	5	18	5	37	5	37	5	ST	Wi	D	Rv	Fab	Spl		152	Go 35x15		Yes	Ol Spr	Yes	ST	Wi	Fab		72 0	
American A & E Co. Pilgrim 100	390	57' 0"	37' 11"	11' 6"	361	48	8	9	6	18	1	36	9	36	8	ST	Wi	D	Rv	Fab	Spl		144	Bx 36x 6		Bx	Ol Spr	Yes	ST	Wi	Fab		69 0	
Amer A & E Co. Pilgrim 71	89	50' 0"	32' 11"	10' 9"	223	34	0	4	0	12	0	30	4	24	6	Sp	Box	Sp	Trs	Fab	Spl		89	11x 32x 6		Bx	Ol Spr		ST	Wi	Fab		13 0	
MULTI-ENGINED PLANES WITH SEATS FOR MORE THAN THREE PERSONS																									
Curtiss Aero & Motor Co Condar	193	91' 8"	57' 6"	16' 6"	1,512	241				53	0			47	6	ST	Wi	O	Rv	Fab	Spl	Tred	244	Bx 54x12		Yes	Ol	Yes	D	Rv	Ply			
Curtiss-Wright Kinner	342 348	34' 6"	24' 10"	10' 0"	352	2	47	8	10	3	27	6	05	1	37	3/8	Wi	D	Rv	Fab	Spl		165	Bx 36x 8		Bx	Ol	Yes	ST	OT	Rv	Fab	15 0	
Curtiss-Keystone Patrician	263	56' 6"	41' 2"	13' 4"	930	64	0	22	8	31	9	02	8	44	6	W	Box	W	G	Fab	Spl		234	44x10		Yes	Ol	Yes	ST	Wi	Fab		75 0	
Bakker YF-13A	96	29' 5"	30' 7"	12' 9"	854	60	0	8	6	20	5	41	0	44	0	W	Box	Ply	G	Ply	Tred		186	Na 44x10		Sa	Cd	Yes	ST	Wi	Fab		82 0	
Bakker YF-32	280	39' 0"	30' 2"	12' 9"	930	91	0	50	4	16	0	90	0	77	4	Sp	Box	Ply	G	Ply	Tred		240	Ex 38x14		Ex	Gr	Yes	ST	Wi	Fab		120 0	
Ford 4-AT F	444	74' 8"	49' 10"	11' 9"	2,285	52	0	12	7	24	2	33	5	39	2	D	Rv	Ay	Ad	Tred		201	Wi 36x 8		Hyd	Aer	Yes	D	Rv	Ad		27 0	
Ford 5	409	77' 10"	50' 5"	12' 0"	2,955	52	0	12	7	24	2	81	7	46	8	O	Rv	Ay	Ad	Tred		223	Bx 44x 15		Hyd	Aer	Yes	D	Rv	Ad		113 0	
Ogden Osprey	332	50' 0"	34' 6"	9' 5"	2,000	20	0	9	2	8	5	24	0	12	5	Sp	Box	Sp	Trs	Fab	Spl		108	Bx 52x 0		Bx	Ol	Yes	ST	Wi	Fab		12 0	
Stinson Tri motor Sm-6000	535	60' 9"	42' 10"	12' 0"	490	42	0	10	0	16	0	42	2	25	0	ST	Wi	D	Rv	Fab	Spl		204	Bx 36x 8		Bx	Aer	Yes	ST	Wi	Fab			
AMPHIBIONS AND FLYING BOATS																									
American Aeronautical S-56, S-31	287 338	34' 1"	25' 2"	10' 1"	262	24	2	9	0	8	0	17	5	15	5	Sp	Box	Sp	G	Fab			64	Wi 20x 4		No	Sc	No	W	Bo	Ply			
Amphibians Inc—Ireland	153 240	40' 0"	31' 0"	12' 2"	325	33	2	15	6	18	2	19	1	23	8	Sp	Ro	D	Sel	Fab	Spl		94	Bx 32x 6		Bx	Ol	No	ST	Wi	Ad			
Amphibians Inc—Privateer	370	38' 0"	28' 0"	8' 6"	198	26	5	11	0	10	9	25	1	16	6	Sp	I	S	Wi	Fab	Cant		62	Kh 21x 6		No	Aw	Yes	Sp	Bo	Ad		3 0	
Consol. Inted Corporation	258	106' 0"	61' 6"	16' 3"	1,000	170	0	23	4	40	2	81	0	54	5	D	Rv	D	Sel	Fab									D	Rv	D	216 0	
C W—Keystone Air Yacht	90	49' 8"	34' 9"	13' 2"	500	60	6	27	4	18	7	52	0	27	6	Sp	Sol	D	Sel	Fab	Spl		74	36x 8		No	Aer	Na	W	Bo	D		20 0	
C W—Keystone Commuter	219	40' 0"	32' 1"	13' 6"	437	30	3	26	0	16	5	46	0	22	0	Sp	Sol	D	Sel	Fab	Spl		93	30x	3	No	Ol	No	W	Bo	D		3 0	
Douglas Dolphin	422	50' 0"	44' 4"	14' 5"	982	40	0	33	4	16	1	45	8	31	2	Sp	Sp	Tra	Fly	Fab	Flot		175	Bx 36x 8		Bx	Gr	Yes	T	Mo	D		78 0	
United Boeing 204	157	39' 8"	32' 8"	12' 0"	475	30	4	14	5	17	1	25	0	28	0	Sp	Ro	Sp	Wnb	Fab										Fly	G, Bo	15 0	
United-Sikorsky S-38	120, 350	21' 8"	40' 3"	13' 10"	720	42	5	15	9	20	0	51	4	35	5	D	Tra	D	Tra	Fab	Hyd			Go		Own	Hyd		W	Sd	Ad			
United-Sikorsky S-39	575	52' 0"	41' 11"	13' 5"	920	30	0	4	8	20	6	29	8	18	5	D	Tra	D	Tra	Fab	Hyd		120	Go		Own	Hyd	Yes	D	Ad	Ad		28 0	
United Sikorsky S-40	454	114' 0"	70' 0"	23' 5"	1,340	100	49	5	32	4	149	1	104	7	D	Tra	D	Tra	Fab	Hyd			205	M 58x14		Own	Hyd	Yes	D	Rv	Ad		125 0	
United-Sikorsky S-41	418	78' 9"	43' 2"	15' 3"	729	60	0	12	6	27	0	60	3	34	2	D	Tra	D	Tra	Fab	Hyd		135	Go		Own	Hyd	Yes	D	Sd	Ad			
Viking V-2	364	42' 4"	30' 4"	10' 4"	359	42	1	4	0	13	0	32	2	27	3	Sp	Box	Ply	G	Fab									W	G	Ply		3 0	

A —Amphibian
Ad —Aldad
Aer —Aeral
Al —Aldin
Amer—American
Aut —Autofan
Apl —Applied
Aw —Air Wheels
Ax —Axelson
B —Biplane
Bak —Bakelite
Be —Beam
Bo —Bolted
Box —Box spar
Br —Brownback
Bx —Bendix
C —Closed
Ca —Cable
Can —Cantilever
Cd —Cord
Cr —Corrugated
Ch —Challenger
Cir —Cirrus
Co —Comet
Com —Compressed
Con —Continental
Cq —Conqueror
Cs —Coiled Springs
Ct —Curtiss
Cv —Conventional
Cy —Cyclone
D —Duralumin
Dcp —Descendasin
Du —Dual
Ex —Extra
F —Flying boat
Fab —Fabric
Fl —Fleetarp
G —Glued
Ge —Genet
Gn —Goodyear
Gr —Gruss
Gt —Gov't test
Gy —Gipsy
H —Hamilton
Ha —Hamilton
His —Hispano
Ht —Heat treated
Hw —Hess Warrior
Hy —Hydraulic
Ile —Ilertzell
I —I section
In —Internal
Ir —Irwin
K —Kinner
Kh —Kelsey-Hayes
L —Landplane
La-l —Ace
Lam —Lambert
Le —Lelland
Lt —Liberty
Lk —Lockheed
Lmd —Laminated
Le —LeShane
Ly —Lycoming
M —Monoplane
Me —Metal
Ma —Messerque
Ms —Mfr's statement
V —New
Na —Navigation
O —Open
Ol —Oleo
Old —Oildraulic
Op —Optional
OX 5—Curtiss
P —Paragon
Pa —Pedal
Pkd —Packard Diesel
Pk —P-K screws
Ply —Plywood
Pn —Pneumatic
Pr —Push Rod
Pwb —P & W Hornet
Pwj —P & W Wasp Je
Pww —P & W Wasp
Q —Sesquiplane
R —Rubber
Re —Reed
Ro —Routed
Ru —Ruen
Rv —Riveted
Sp —Spruce
Sa —Sausedite
Sh —Shock Cord
Sed —Screwed
Sd —Stamped
Sh —Sheet
Sk —Stick
Sol —Solid
Spl —Spliff
St —Standard
Str —Straight
Su —Supreme
Sy —Skory
Sz —Szekely
T —Tubing
Tr —Trombone
Tred —Treadle
Trs —Truss
W —Wood
Wa —Walter
War —Warner
Was —Warren Truss
Wb —Wire braced
We —Westinghouse
Wb —Wheel
Wi —Wire
Wl —Weighed
Wr —Wright
Wt —Wind Tunnel
Ww —New Whirlwind
Y —Yankee
Z —Szeplane
* —Without engine

American engine specifications

AVIATION does not assume responsibility for the figures given

Manufacturer or Agent	Engine	Cooling system	Cylinder arrangement	Number of cylinders	Strokes per cycle	Propeller drive	Rated h.p. and r.p.m. at sea level	Maximum hp and r.p.m. at best level	Weight dry with unit base or starter	Weight per rated hp	Bore and stroke (in.)	Compression ratio	h.p.m.	Displacement (cu.in.)	Frontal area (sq. ft.)	Diameter of mounting ring or distance between bearers (in.)	Fuel consumption at rated hp.	Starter (in.)	Generator (cut-in speed)	Oil consumption lb. hp. hr.	Valve mechanism	Number of intake valves per cylinder	Make spark plugs and type	Number of exhaust valves per cylinder	Type of ignition	Make ignition	Number of carburetors	Make carburetor	Starter	Are vacuum assemblies provided	Shipping weight carried	Dimensions of Crate—length, width, height	Price at factory
Aeronautical Corp. of America	Aeronautical E-102	A	Opp	4	2	D	90–2125	55–2350	140	2.55	4⅛×4	5.0	114	213	5	20	0.52	0.015	24 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Aeronautical Corp. of America	Aeronautical E-102A	A	Opp	4	2	D	90–2125	55–2350	140	2.55	4⅛×4	5.0	114	213	5	20	0.52	0.015	24 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Aeronautical Corp. of America	Aeronautical E-102A	A	Opp	4	2	D	90–2100	55–2350	140	2.55	4⅛×4	5.0	114	213	5	20	0.52	0.015	24 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
A-C E-C Corp	Comet	A	Rad	7	4	D	165–1900	185–2200	400	2.42	5¼×5½	5.2	212	712	6	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
A-C E-C Corp	Comet Hs-Driven	A	Rad	7	4	D	165–1900	185–2200	400	2.42	5¼×5½	5.2	212	712	6	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Continental Aircraft Engine Co	A 70-2	A	Rad	7	4	D	155–2000	183–2226	415	2.5	4½×4½	5.2	324	724	6	20	0.52	0.025	24 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Continental Aircraft Engine Co	A-40	A	Opp	4	4	D	37–2250	39–2800	130	3.5	4½×4½	5.2	324	324	3.5		0.52	0.025	24 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Curtiss Aeroplane & Motor Corp	Challenger	A	Opp	9	4	D	300–2150		1000	3.33	5½×6½	5.0	1106	1106	12	44	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Curtiss Aeroplane & Motor Corp	Conqueror	A	Rad	12	4	D	600–2800	655–2800	840	1.40	5½×6½	5.0	2212	2212	12	44	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1950	74×37×37	4495
Curtiss Aeroplane & Motor Corp	Whirlwind 165	A	Rad	7	4	D	165–1900	185–2200	400	2.42	5¼×5½	5.2	212	712	6	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Curtiss Aeroplane & Motor Corp	Whirlwind 240	A	Rad	9	4	D	240–2800	265–3000	600	2.5	5¼×6½	5.2	318	1068	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Curtiss Aeroplane & Motor Corp	Whirlwind 300	A	Rad	9	4	D	300–3000	325–3200	600	2	5¼×6½	5.2	318	1068	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Curtiss Aeroplane & Motor Corp	Whirlwind 400	A	Rad	12	4	D	400–3000	425–3200	800	2	5¼×6½	5.2	318	1424	12	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Curtiss Aeroplane & Motor Corp	Cyclone 525	A	Rad	9	4	DG	525–1900	552–1900	1025	1.95	6×7	5.0	1260	1780	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Curtiss Aeroplane & Motor Corp	Cyclone 575	A	L	9	4	DG	575–1900	605–1900	1055	1.84	6×7	5.0	1823	2576	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Curtiss Aeronautical Corp	Gypsy L-320	A	L	12	4	D	90–1950	96–1950	285	3.17	4½×5½	5.0	520	1128	6	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Detroit Aircraft Corp	Detroit Diesel	A	Opp	2	2	D	30–1750	36–1750	135		4½×4½	14	90	90	4	20	0.45	0.015	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Detroit Aircraft Corp	Detroit Diesel	A	Opp	4	2	D	60–1750	72–1750	270	3.75	4½×4½	14	180	180	4	20	0.45	0.015	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Detroit Aircraft Corp	Detroit Diesel	A	Opp	6	2	D	90–1750	108–1750	405	3.75	4½×4½	14	270	270	6	20	0.45	0.015	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Detroit Aircraft Corp	Detroit Diesel	A	Opp	8	2	D	120–1750	144–1750	540	3.75	4½×4½	14	360	360	8	20	0.45	0.015	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Dodge Brothers	Dodge	A	Rad	4	4	D	45–1750	46–1750	135		4½×4½	5.4	90	90	4	20	0.45	0.015	6 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Dodge Brothers	Dodge	A	Rad	6	4	D	70–1750	72–1750	270	3.75	4½×4½	5.4	180	180	6	20	0.45	0.015	6 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Dodge Brothers	Dodge	A	Rad	8	4	D	90–1750	96–1750	405	3.75	4½×4½	5.4	270	270	8	20	0.45	0.015	6 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Franklin Engine Co	Franklin	A	Rad	6	4	A	110–1900	120–2100	510	3.75	5½×7	5.0	510	1000	6	30	0.52	0.025	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Franklin Engine Co	Franklin	A	Rad	9	4	A	165–1900	185–2100	765	3.75	5½×7	5.0	765	1500	9	30	0.52	0.025	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Franklin Engine Co	Franklin	A	Rad	12	4	A	220–1900	240–2100	1020	3.75	5½×7	5.0	1020	2000	12	30	0.52	0.025	12 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Fred'k & Whitney Aircraft Co	Wasp C1G	A	Rad	9	4	D	300–2200	300–2200	710	2.36	5¼×5½	5.2	1106	1106	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Fred'k & Whitney Aircraft Co	Wasp D	A	Rad	9	4	D			710	2.36	5¼×5½	5.2	1106	1106	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Fred'k & Whitney Aircraft Co	Wasp SC-1	A	Rad	9	4	D	300–1900		710	2.36	5¼×5½	5.2	1106	1106	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Fred'k & Whitney Aircraft Co	Hornet A	A	Rad	9	4	DG	525–1900		1025	1.95	5½×6½	5.2	1260	1780	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Fred'k & Whitney Aircraft Co	Hornet A 2G	A	Rad	9	4	DG	575–1900		1055	1.84	6×7	5.0	1823	2576	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Fred'k & Whitney Aircraft Co	Hornet H-1	A	Rad	12	4	DG			1840	1.84	6×7	5.0	3646	5152	12	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Fred'k & Whitney Aircraft Co	Hornet D	A	Rad	18	4	DG			2760	1.84	6×7	5.0	5469	7728	18	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Fred'k & Whitney Aircraft Co	Wasp Jr. SIA	A	Rad	9	4	D	400–2300		565	1.4	4½×5½	5.4	565	800	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Fred'k & Whitney Aircraft Co	Wasp Jr. SIB	A	Rad	9	4	D			565	1.4	4½×5½	5.4	565	800	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Stanley Aircraft & Eng Co	SEC-3 Mod 1	A	Rad	5	4	D	45–1750	46–1750	135		4½×4½	5.4	90	90	4	20	0.45	0.015	6 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Stanley Aircraft & Eng Co	SEC 3 Mod 1L	A	Rad	7	4	D	70–1750	72–1750	270	3.75	4½×4½	5.4	180	180	6	20	0.45	0.015	6 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Stanley Aircraft & Eng Co	SEC 3 Mod 1F	A	Rad	9	4	D	90–1750		405	3.75	4½×4½	5.4	270	270	8	20	0.45	0.015	6 V	0.025	A	1	AC J-9	1	ZM	BG	1	Zen	Y	Y	1000	74×37×37	2495
Wasaer Aircraft Corp	Search	A	Rad	7	4	D	110–1850	120–1925	270	2.45	4½×5½	5.2	270	425	7	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Wright Aeronautical Corp	Conqueror	A	W V-type	12	4	DG	600–2800	655–2800	840	1.40	5½×6½	5.0	2212	2212	12	44	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1950	74×37×37	4495
Wright Aeronautical Corp	Whirlwind 165	A	Rad	7	4	D	165–1900	185–2200	400	2.42	5¼×5½	5.2	212	712	6	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1350	74×37×37	3495
Wright Aeronautical Corp	Whirlwind 240	A	Rad	9	4	D	240–2800	252–3000	600	2.5	5¼×6½	5.2	318	1068	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Wright Aeronautical Corp	Whirlwind 300	A	Rad	9	4	DG	300–3000	325–3200	600	2	5¼×6½	5.2	318	1068	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Wright Aeronautical Corp	Whirlwind 400	A	Rad	12	4	DG	400–3000	425–3200	800	2	5¼×6½	5.2	318	1424	12	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Wright Aeronautical Corp	Cyclone 525	A	Rad	9	4	DG	525–1900	552–1900	1025	1.95	6×7	5.0	1260	1780	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Wright Aeronautical Corp	Cyclone 575	A	L	9	4	DG	575–1900	605–1900	1055	1.84	6×7	5.0	1823	2576	9	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495
Wright Aeronautical Corp	Gypsy L-320	A	L	12	4	D	90–1950	96–1950	285	3.17	4½×5½	5.0	520	1128	6	30	0.52	0.025	24 V	0.025	A	2	AC J-9	2	ZM	BG	2	Zen	Y	Y	1650	74×37×37	4495

A— Air cooled
Al— Aluminum Alloy
Al— Aluminum in Head
Ba— Robert Bosch
Be— Scintilla booster magneto
C— Cast iron

Ch— Champion
Cm— Compression
D— Direct
Dp— Duplex
Dx— Dixie
DM— Dual Magneto

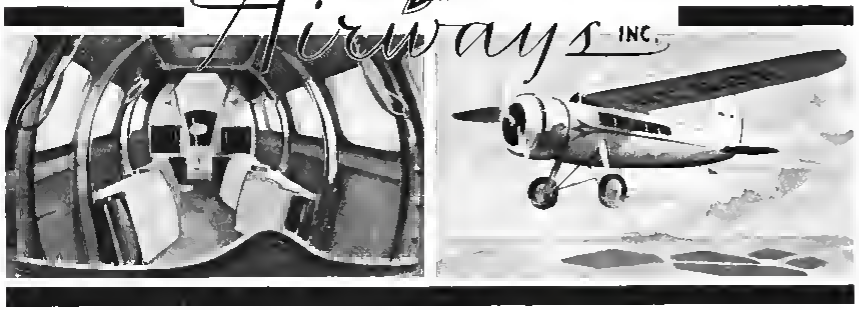
Zr— Zenjun
G— Geared
G1— 1.5 to 1 reduction gear
G2— 2 to 1 reduction gear
G4— 5.4 reduction gear
GE— General Electric

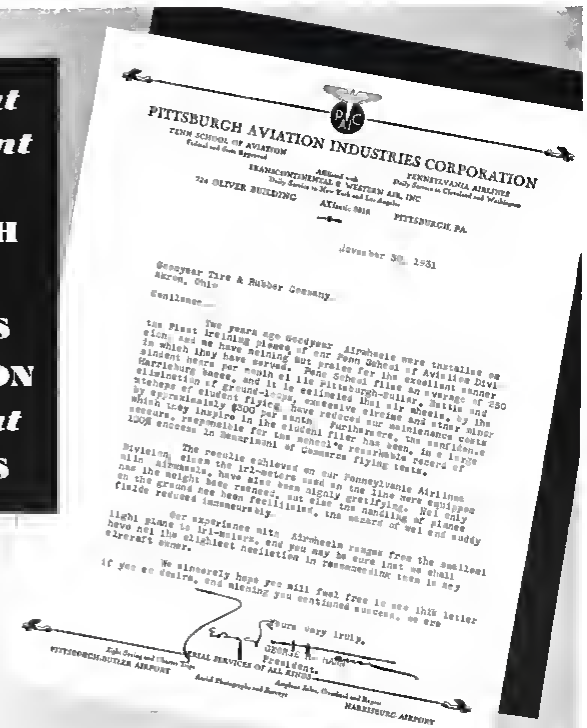
H— Hexagon
Hd— Hexhead
Hy— Hyatt
I— Inverted
L— Cylinders in line
Lh— L-head

M— Monel
Mg— Magneto
N— Nickel iron
O— Outboard
Ohv— Overhead valve

PC— push rods and rocker arms
Rad— Radial
Rad 8— Staggered Radial
S.A.E.—S. A. E. mounting
Sd— Stromberg
Sm— Scintilla—Dual Magneto
Sp— Stromberg

Sr— Splined
St— Standard
T— T. T. L. Electric
U— Unmounted
W— Wright
Wi— Wi Bird
Zen— Zenith





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724 OLIVER BUILDING — ATlantic 0816 — PITTSBURGH, PA.

December 30, 1931

Goodyear Tire & Rubber Company
Akron, Ohio

Gentlemen:

Two years ago Goodyear Airwheels were installed on the first training plane of our Penn School of Aviation Division, and we have nothing but praise for the excellent manner in which they have served. Penn School flies an average of 250 student hours per month at its Pittsburgh-Butler, Butler and Harrisburg bases, and it is estimated that since Airwheels, by the elimination of ground-loops, excessive strains and other minor mishaps of student flying, have reduced maintenance costs by approximately $300 per month.

Since the tri-motors used on the line were equipped with Airwheels, the weight has been reduced, the handling of planes on the ground has been facilitated, the hazard of wet and muddy fields reduced immeasurably.

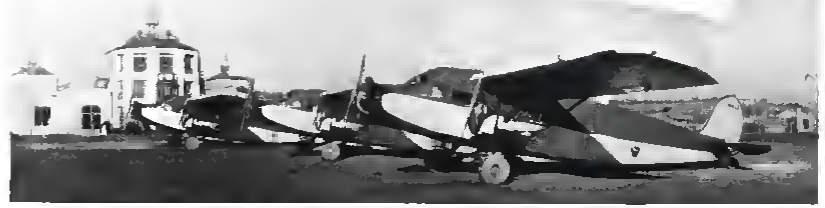
Our experience with Airwheels ranges from the smallest light planes to tri-motors, and you may be sure that we shall have no hesitation in recommending them in any aircraft owner.

We sincerely hope you will feel free to use this letter if you so desire, and wishing you continued success, we are

Yours very truly,

GEORGE M. [illegible]
President.

PITTSBURGH-BUTLER AIRPORT — SPECIAL SERVICES OF ALL KINDS — HARRISBURG AIRPORT



The Facilities and Services of CURTISS·WRIGHT

THE Airway Map of the United States indicates the scope of Curtiss-Wright service. Wherever you fly—as the pilot of your own plane or as a passenger on one of the scheduled air lines—the facilities of this nation-wide organization are constantly at your command.

MANUFACTURING.—Curtiss-Wright manufacturing divisions cover more than 1,700,000 square feet of floor space. Curtiss Aeroplane & Motor Company, Inc., Buffalo, N. Y., and Keystone Aircraft Corporation, Bristol, Pa., design and build advanced types of military aircraft for the Army and Navy—observation, pursuit, attack, bombardment planes, flying boats—and huge 18-passenger commercial transports.

The Curtiss-Wright Airplane Company, Robertson, Mo., builds training and sport planes, amphibians and fast commercial types, ranging up to 8-place transports. During 1931 Curtiss-Wright sold 36% of the total number of commercial planes produced by aircraft manufacturers in the United States.

Curtiss-Wright Army Planes Flying Cross-Country

Wright Aeronautical Corporation, Paterson, N. J., builds six different types of aircraft engines—including the famous Whirlwind, Cyclone and Conqueror—for the Army and Navy, airplane manufacturers and air transport operators. Wright Engines power air lines around the world.

AIRPORTS:—Over $30,000,000 have been invested by Curtiss-Wright in a nation-wide chain of Airports and Flying Service Bases—situated close to the leading centers of population, industry and finance. They are equipped with administration buildings, restaurants, classrooms, repair shops and modern, heated hangars, having a total airplane storage space of 1,150,000 square feet, providing complete facilities for many of the nation's leading air lines, including Eastern Air Transport, Inc., Transcontinental & Western Air, Inc., National Air Transport, Inc., Century Air Lines, Inc., and Pennsylvania Air-lines, Inc.

SERVICE:—Approximately 90% of all the aircraft in the United States are within easy flying distance of Curtiss-Wright ports and authorized Wright Service Stations. Curtiss-Wright Bases are Department of Commerce approved repair stations, employing licensed aircraft and engine mechanics. Full machine shop and tool equipment are maintained. Stocks of 4,000 parts and accessories are carried. Labor and material prices are standardized.

FLYING SCHOOLS:—More than 5,000 competent pilots have been trained by Curtiss-Wright Flying Service. Other functions of this organization are: Airplane Sales and Service, Ground School Training, Aviation Mechanics and Engineering Courses, Aerial Photography, Sightseeing Flights and Charter Service—which ties up logically with the operations of scheduled transport operators.

Curtiss-Stemberg Airport, East St. Louis

Curtiss-Wright Facilities are Nation-Wide

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These are the facilities of Curtiss-Wright . . . facilities which have given this organization leadership since the early pioneer days of Aviation. CURTISS-WRIGHT CORPORATION, 29 West 57th Street, New York City

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29 West 57th Street, *New York City*

CURTISS AEROPLANE & MOTOR COMPANY, INC., *Buffalo, N. Y.*

WRIGHT AERONAUTICAL CORPORATION, *Paterson N J.*

KEYSTONE AIRCRAFT CORPORATION, *Bristol, Pa.*

CURTISS WRIGHT AIRPLANE COMPANY, *Robertson, Mo.*

CURTISS-WRIGHT EXPORT CORPORATION
29 West 57th Street, *New York City*

CURTISS WRIGHT FLYING SERVICE
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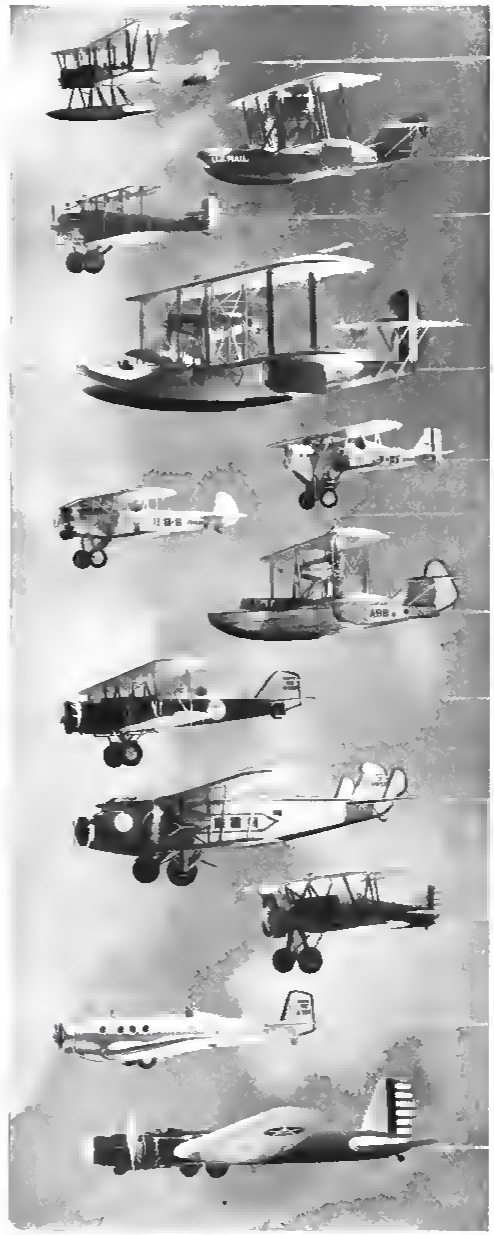
•

Wright Aeronautical Corporation

CURTISS·WRIGHT CORPORATION

A remarkable picture of BOEING progress!

Sixteen years of advancement in the manufacture of Boeing airplanes are represented in this one illustration — dating from the training seaplane of 1916 to the high-speed streamlined planes of 1932. These planes — selected as representative of stages of Boeing development — are only a few of the many models designed by Boeing engineers. Today — more than ever — the Boeing emblem is recognized as a standard of stamina, performance, and progress by which all military and commercial aircraft may be judged. . . . Boeing Airplane Company, Seattle, Subsidiary of United Aircraft and Transport Corporation.



1916 *(B&W) — The first airplane produced by the Boeing Airplane Company, a two place biplane trainer built as a seaplane.*

1919 *(B-1)—One of the first Boeing commercial airplanes a flying boat operated in airmail service for many years over Puget Sound*

1921-22 *(MB-3A)—Army pursuit plane, two hundred of which were built by the Boeing Airplane Company.*

1925-26 *(PB-1)—Navy patrol boat weighing thirteen tons, the largest Boeing plane ever built.*

1926-27 *(FB-5) — Carrier-type fighter, built by the Boeing Airplane Company for the Navy.*

1927-28 *(F3B-1)—Boeing Navy carrier fighter with air-cooled Wasp engine*

1928-29 *(204)—Flying boat, an advanced development from the early model of 1919.*

1929 *(40-B4) — Four-passenger Hornet powered mail plane of the series started in 1927 when the Boeing Airplane Company entered the field of mail-passenger plane construction.*

1929-30 *(80-A) — Transport plane powered with three Hornets designed for mail-passenger operation over United Air Lines, the world's largest air transport system.*

1930-31 *(Army Type P-12C) (Navy Type F4B-2) — Wasp-powered pursuit plane, one of the fastest fighting planes produced today.*

1931-32 *(Monomail)—A development in mail passenger transport planes, an all-metal Hornet powered monoplane with retractable landing gear.*

1931-32 *(Bomber) — High-speed bombing plane of all-metal construction carrying more than a ton of bombs and armament. Twin Hornet monoplane with retractable landing gear.*

LOOKING FORWARD

The General Aviation Manufacturing Corporation enters 1932 with all its great resources pledged to the development of new and advanced types of aircraft.

To this goal it is devoting all the skill and enterprise for which the engineers and designers of this company have long been noted . . . all the experience gained in over a decade of fine aircraft building . . . all the modern manufacturing facilities of the great Curtiss-Caproni plant at Baltimore, now the home of General Aviation Manufacturing Corporation.

To this unique union of ability, experience and facilities, add the reputation for exceptional performance and dependability which G. A. M. C. ships have always enjoyed, and you will understand why it is being persistently rumored among the airwise: *"Good things are happening at Baltimore."*

GENERAL AVIATION MANUFACTURING CORPORATION

Division of General Aviation Corporation

P. O. Address: Dundalk, Baltimore, Maryland

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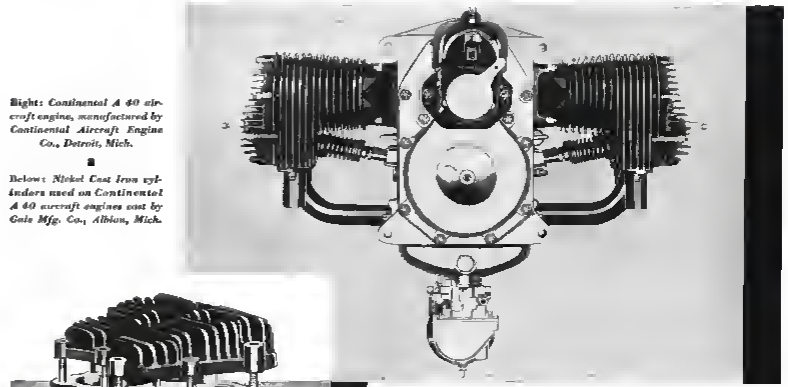
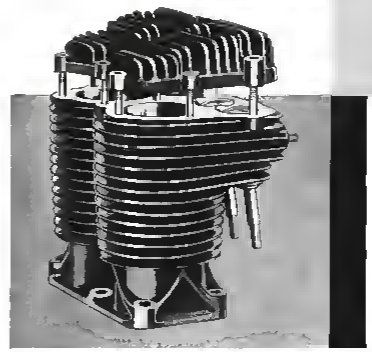


Right: Continental A 40 aircraft engine, manufactured by Continental Aircraft Engine Co., Detroit, Mich.

Below: Nickel Cast Iron cylinders used on Continental A 40 aircraft engines cast by Gale Mfg. Co., Albion, Mich.



Continental's new 4-cylinder airplane engine has long-wearing NICKEL CAST IRON *cylinders*

● Following extensive tests in one of the world's most complete aircraft laboratories, Nickel Cast Iron cylinders have been selected for the new 4-cylinder Continental airplane engine. ● Nickel Cast Iron, called "the longest wearing cylinder material known today", is standard for cylinders in approximately 16 American airplane engines. By adding up to 3% Nickel to a proper base mixture, high strength and exceptional wear-resistance are consistently obtained in cylinder castings. Moreover, light section cooling fins are grey and consequently tough throughout ● Without question, Nickel Cast Iron "performs better longer". That's why airplane engine builders and other important manufacturers specify it for quality products.

Nickel CAST IRON
A BETTER MATERIAL FOR MODERN NEEDS

Our casting specialists will gladly discuss your problems with you

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Miners, refiners and sellers of Nickel ‖ Sole producers of Monel Metal
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Flying from Floating Fields

Think of a plane that can accelerate from rest to flying speed in a short run on deck. Picture a speed range extending from the fast work of observation to relatively slow deck landing. Consider the structural strength needed for coming in continually on steel and being stopped by arresting gear. Add to those specifications easy handling, flashing performance and intrinsic reliability and you have the Chance Vought Corsair. Chance Vought Corporation, East Hartford, Connecticut. Division of United Aircraft & Transport Corporation.

CHANCE VOUGHT CORPORATION

Does your RADIO RATTLE like a stone drill?

Hahn Plugs will silence ignition noise without affecting engine performance.

A WIDER range of radio reception . . . easier pick-up of beacon signals . . . and unhindered communication with ground stations will result when you change to Hahn Radio Shielded Spark Plugs. For Hahn Plugs, installed in conjunction with a shielded ignition system, completely banish every trace of ignition noise and interference.

Unlike most means of eliminating ignition interference, Hahn Plugs do not lower engine efficiency. In fact, Hahn Plugs frequently give more r.p.m. and invariably give longer life than any other type of spark plug.

Service records of transport operators show that Hahn Plugs have an average life of more than 500 flying hours. Some have exceeded 800 hours. Inspection is usually required only every 100 flying hours.

The Hahn Radio Shielded Spark Plug is radically different from other plugs in several ways. One of the most important features is the unique electrodes. Their large area prevents burning away and assures a constant gap with infrequent adjustments. The large center electrode furthermore, acts as a baffle and decreases fouling.

The Hahn terminal connection makes a positive contact. It is water, oil and dirt proof. The terminal is interchangeable with any Hahn Plug and fits any type of harness.

The Hahn Plug is insulated with the best grade of mica.

Our engineers are specialists in radio shielding. They have developed complete shielding installations for the ignition system that are surprisingly low in cost. We will gladly send you complete details without any obligation.

Walter Kidde & Company, Inc.
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New York

HAHN *Radio-Shielded Spark* **PLUG**

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2—Compactness. (12 volt Exide shown is 14 1 8" long 7 1-4" wide and 10 3 16" high)

3—Light weight — (Transport size battery shown weighs 70 lbs. Is used for cranking, high wattage lamps, radio and ignition)

4—Long life, due to highest quality materials and 43 years battery building experience

5—Twelve types and sizes to meet every aircraft service

Before you buy your next batteries, see an Exide representative. Discuss your battery problems with him. Or, write us for further information on the many types of Exide Aircraft Batteries and their varied applications.

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Gulfpride Oil holds its body at high temperatures and resists breaking down under motor heat. It is highly resistant to oxidation and emulsifying action.

Gulfpride Oil is made in five viscosities 75-100-120-150 and 200 at 210°F, providing a superior lubricant for all types of aircraft motors, under all operating conditions.

Ask for Gulfpride Oil and you'll never be grounded because of oil-caused trouble.

...*There's good reason why*

THIS OIL HOLDS ITS BODY

It's a big mistake to think that "all oils are about alike." Read quick facts here and see why . . . . . .

It's a fact that Gulfpride Oils show remarkably flat viscosity-temperature curves. That is, they hold their body well under extreme high temperature operating conditions, yet do not become objectionably stiff and tacky at low starting temperatures.

Gulfpride Oils permit a smoother, freer running motor. You can see the difference...in higher tachometer readings and in greater power. And sometimes that extra lift comes in handy.

Gulfpride Oils form less than one-fifth as much carbon by Conradson test as the next best Paraffin Base Oil of comparable viscosity on the market. They keep sweet running motors sweet.

Add up these advantages...resistance to heat, flat viscosity curve, freer running motor and low carbon formation...and you see why Gulfpride Oils gives you more *air hour*. Ask for it at the field.

GULF REFINING COMPANY
General Sales Offices, Pittsburgh, Pa., U S A

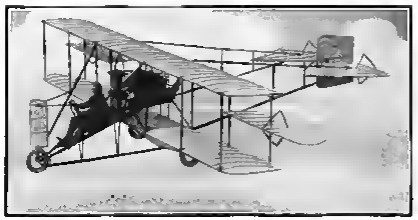
Gulfpride Oil

GULF

• GULF REFINING COMPANY •

Janus—god of all beginnings (hence, the name of this month of January)—with his two opposite faces as though reviewing the past and looking into the future.

IT IS FITTING THAT, AT THE BEGINNING OF A NEW YEAR, WE SHOULD LOOK BACK OVER PAST ACHIEVEMENT TO INSPIRE US TO GREATER EFFORT AND ACCOMPLISHMENT IN THE FUTURE



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First Martin Glider	1907
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(Subsidiary of Bendix Aviation Corporation)

Photo by R. B. Bult

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"SQUEEZE" the throttle for the take-off ... you need a powerful gasoline—a gasoline that gets your plane in the air quickly, without faltering.

Socony Aviation Gasoline, tested and proved under actual flying conditions in our own Socony Test Plane, and used by leading pilots when they fly in New York and New England, insures a carefree take-off ... gets your plane in the air fast.

When your engine is fueled with Socony Aviation Gasoline and lubricated with Socony De-waxed Motor Oil, you have a right to expect perfect engine performance, and you get it.

Try this combination next time.

SOCONY

AVIATION GASOLINE • DE-WAXED MOTOR OIL

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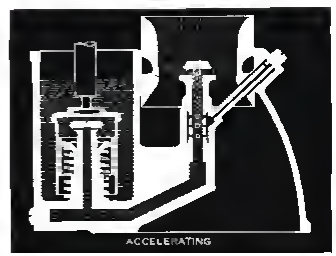
WHEN a pilot opens the throttle quickly, he wants smooth and positive acceleration. It is his greatest factor of safety in many tight situations.

Temporary enrichment of mixture required for such acceleration is automatic with Stromberg Aircraft Carburetors. That's why so many good pilots prefer them. The accelerating pump, for use on engines which require a large accelerating charge for cold weather operation, is a new and exclusive Stromberg construction. It gives a positive and definite accelerating charge, under all conditions, regardless of the situation existing in the carburetor. This charge is delivered in a momentary spurt of fuel followed by a sustained discharge, lasting several seconds.

Stromberg's background represents 22 years of experience and research. Perhaps their engineers can be of service to you.

[Stromberg Carburetors are used on over 95% of the aircraft engines now being built in the United States.]



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PARTS of a complete Travelair plane K2080 including OX 5 motor for sale Write for prices. Heather 331 W. Duval St., Jackson ville, Florida.

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WACO "S" Kinner 155 Starter $3 100 Waco "F" Warner Metal Prop Starter $2 750 Jr. Robin $2 250 Fairchild FC2 $2 500 OX Waco 10 $800 3 Waco Gliders $150 All in excellent condition and licensed Airview Flying Service, Red Bank, N J

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WANTED: A radial motor of about 40 horsepower Address E A Stalker 302 East Engineering Building Ann Arbor Michigan

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PROFESSIONAL SERVICES

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WRIGHT "WHIRLWIND"
and
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The Wright "Whirlwind"... first commercial radial air-cooled engine, developed eight years ago ... has flown countless miles and established many major records.

It's quite significant that Scintilla Magnetos are standard equipment on all "Whirlwinds"; have been for eight years.

SCINTILLA MAGNETO CO., INC.
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Contractors to the U. S. Army and Navy
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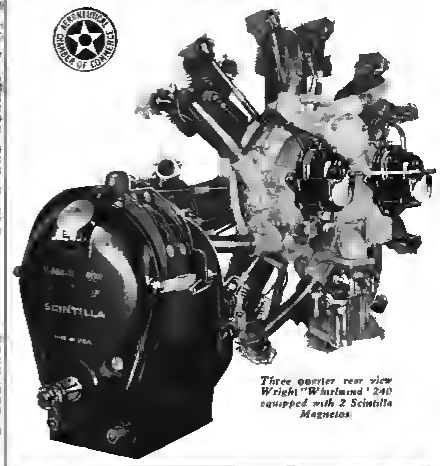

Three quarter rear view Wright "Whirlwind" 240 equipped with 2 Scintilla Magnetos

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SIMPLICITY
ACCESSIBILITY

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Can Cut "Warming-Up" Time in Half with G-E Oil Immersion Heaters

Type Y 2092 heater inserted in oil tank

The Type Y-2092 heater includes 3 heat snap switch, flexible leads, and standard attachment plug

GENERAL ELECTRIC oil immersion heaters for aircraft engines are designed to heat the lubricating oil without the aid of the engine and without the necessity of draining and refilling the oil tank in cold weather. They cut "warming-up" time in half. And they are intended for use as a part of the ground equipment rather than for permanent installation in ships, therefore, one heater will serve a number of planes. G-E oil immersion heaters are portable, convenient to use, and shaped for easy insertion through oil-tank filler caps. The heating units can be supplied for operation on either 110- or 220-volt electric-lighting circuits. Write to-day for Bulletin GEA-1177B, which describes these heaters in detail. Address the General Electric Company, Schenectady, N. Y.

Type Y-2039 includes flexible leads and standard attachment plug

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712 9

Caterpillar Tractor Co., Peoria, Ill., U.S.A.

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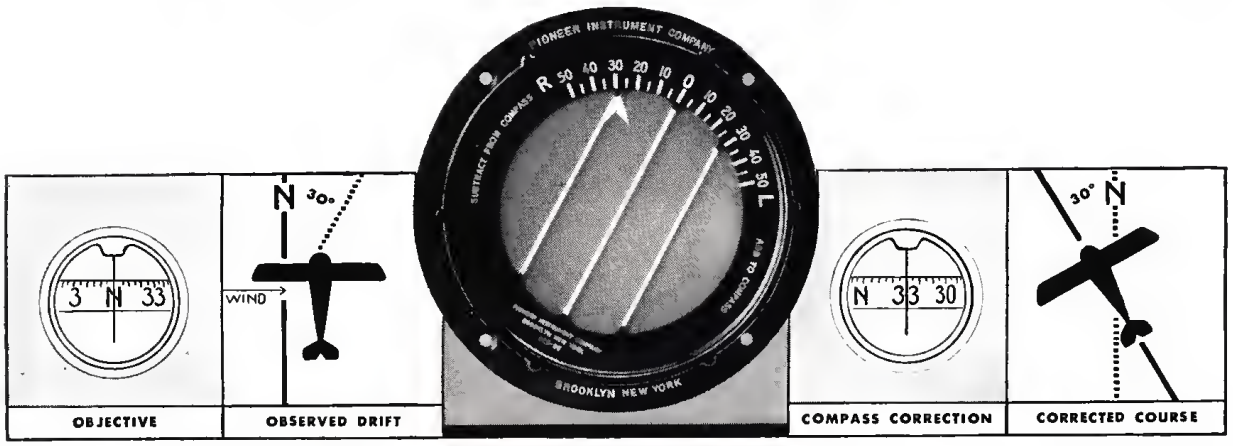
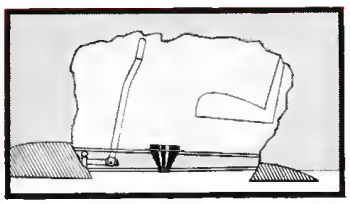


TO COMPASS FLYING

THE NEW PIONEER DRIFT INDICATOR

The angle of drift, a factor in compass flying which up to the present has been largely a matter of guesswork, can now be observed directly and accurately with the new Pioneer Drift Indicator.

Any pilot or navigator with a few practice trials can quickly and easily determine his drift a few minutes after taking off. Drift should also be checked at frequent intervals. The fact that a reading may be taken on ground lights makes the Pioneer Drift Indicator equally valuable for night flying.



The above diagram shows the Pioneer Drift Indicator as actually installed in the floor of a plane. Notice its convenience. A remote operated model is also available. It is known as type 642 and is rotated by means of a flexible shaft which is connected to a small crank unit mounted on the instrument board.

EASY TO OPERATE

The Drift Indicator is located in the floor of the plane between the pilot or navigator's feet. Turn the dial until images on the ground are moving parallel with the lines on the Drift Indicator. Note the indicated angle of drift and add or subtract it (the dial tells you which) from the actual compass course. The adjusted compass reading will take you directly to your destination.

The new Pioneer Drift Indicator is simple to operate, easy to install, and surprisingly inexpensive. Write us for further information and prices.

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